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Contents, page 803

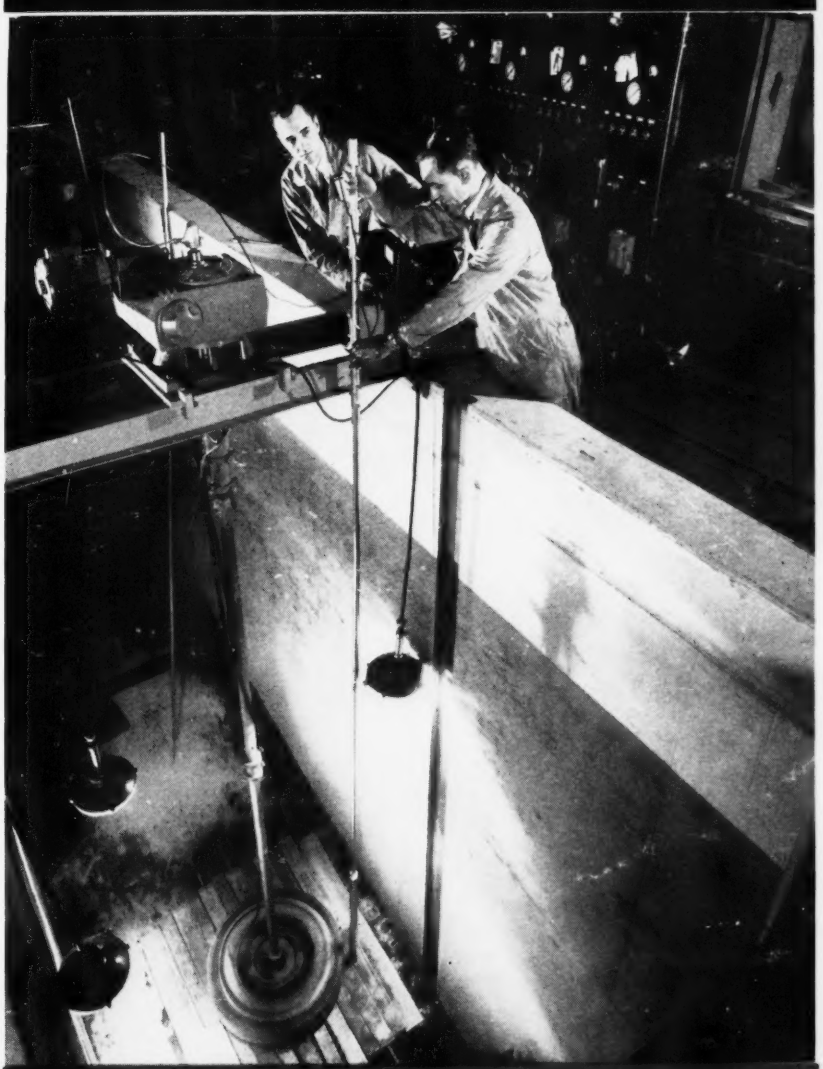
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PREVIEW OF THINGS TO COME?

• • •

Goodrich Scientists Vulcanize Tires With Atomic Energy At National Reactor Testing Station In Idaho

See page 926



CURING SYSTEMS FOR IMPROVED AGING RESISTANCE

By Ossefort, Shaw, Bergstrom, page 867

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RUBBER WORLD

MARCH, 1957

VOLUME 135, NUMBER 6

FEATURES

NATURAL RUBBER QUALITY; CONSUMER GAINS AND LOSSES ..... R. G. Seaman 865

An editorial.

CURING SYSTEMS FOR IMPROVED AGING RESISTANCE OF RUBBER VULCANIZATES—I
Z. T. Ossefort, R. F. Shaw, E. W. Bergstrom 867

Long-term atmospheric and shelf aging and the accelerated aging of unstressed rubber vulcanizates have indicated that proper choice of curing system is the most important means of obtaining rubber items with superior age resistance.

FACTORS AFFECTING LABORATORY CUT-GROWTH RESISTANCE OF COLD SBR TREAD STOCKS
E. E. Auer, K. W. Doak, I. J. Schaffner 876

Important new relations between the laboratory crack-growth resistance of styrene-butadiene rubber vulcanizates and their modulus and breaking elongation have been established.

ASTM COMMITTEE D-11 FEBRUARY MEETING 886

Need of improved material definitions; research activities; future international meetings; and reports of work of 17 subcommittees are included in this meeting account.

SOUTHERN RUBBER GROUP PANEL DISCUSSION ON "ELASTOMERS FOR SPECIFIC APPLICATIONS" 890

Major commercial synthetic elastomers, natural and reclaimed rubbers are discussed for compounder and technologist, together with answers to questions, in this report.

AKRON RUBBER GROUP PANEL DISCUSSION ON "PHYSICAL TESTING IN THE RUBBER AND PLASTICS INDUSTRIES"—I 903

Equipment, testing of plastics and insulated wire, fabrics, tire compounds, mechanical goods, and specialty rubbers are covered in the report of this symposium.

DEPARTMENTS

Meetings and Reports	886	New Materials	947
News of the Month		New Products	949
United States	911	Book Reviews	950
Obituaries	936	New Publications	951
Financial	938	Market Reviews	954
Calendar of Coming Events	941	Synthetic Rubber Prices	958
News from Abroad	942	Compounding Ingredients Prices	960
New Equipment	945	Advertisers Index	971

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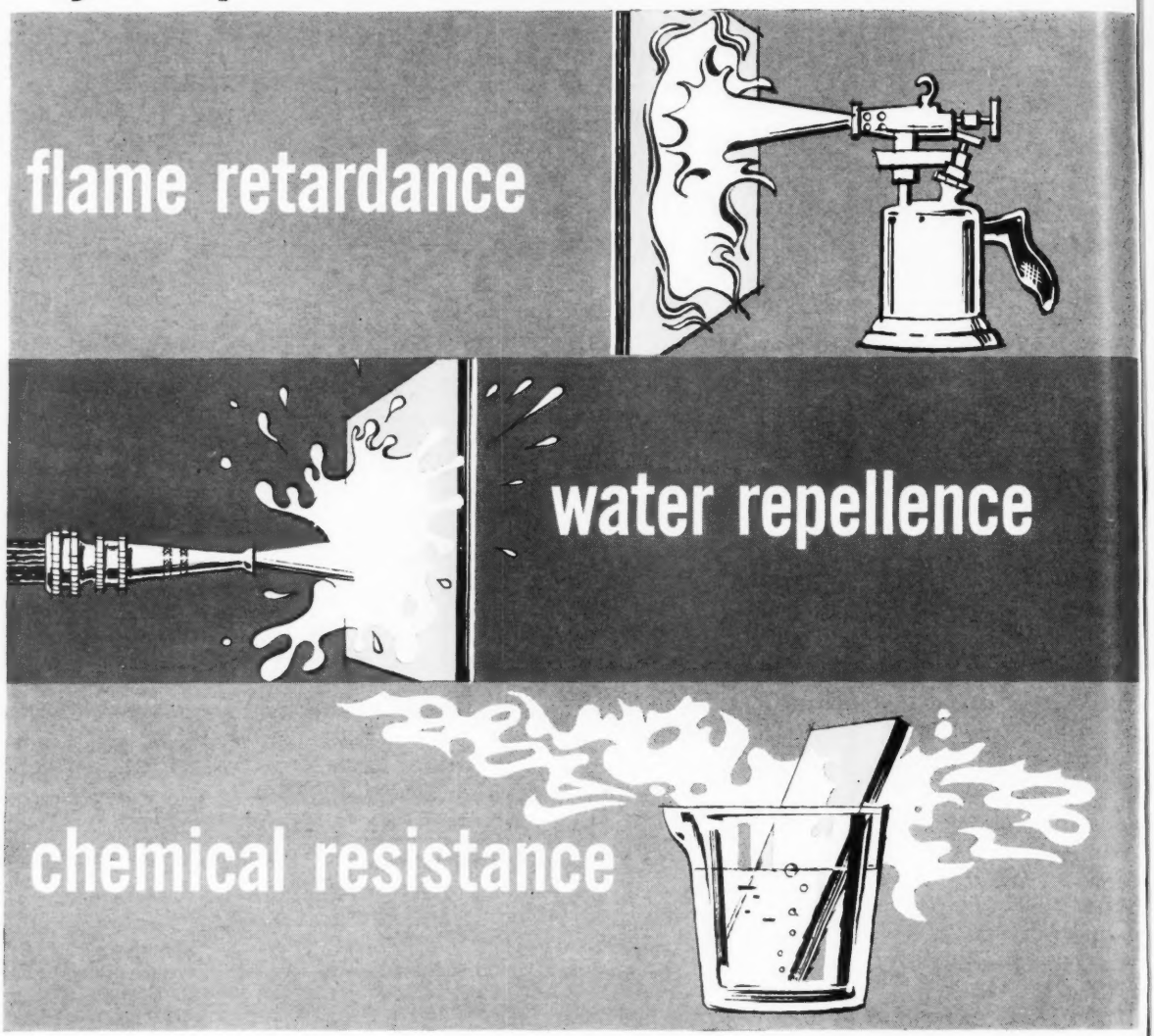
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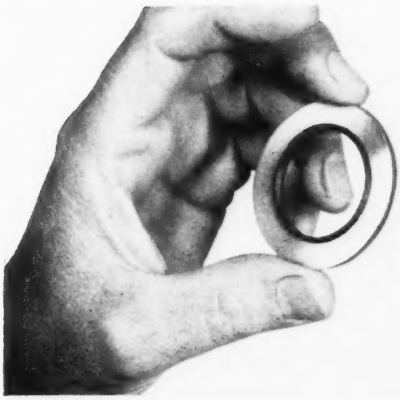
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* Hycar meets aeronautical specs



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AMS 3215F . . . requiring continuous or alternating exposure to both aromatic and non-aromatic fuels, for products such as gaskets, diaphragms, bushings, grommets, and sleeves. A Hycar 1042 compound meets the specification.

AMS 7260 . . . requiring good resistance to fuels, plus flexibility at temperatures down to 65° below zero. A Hycar 1043 compound meets the standards; applications include gland type packings and flexible couplings.

AMS 7270B . . . properties required include fuel resistance, flexibility at −65°F, aging in hot oil, cyclic fuel aging, and dry heat aging, for sealing ring application. A Hycar 1042 formulation is satisfactory.

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AMS 7271 . . . requiring service at temperatures to −65°F, with exposure to fuels, for sealing rings. Here a blend of Hycar 1042 and GR-S 1501 passes requirements.

For further information on Hycar nitrile rubber, write Dept. ES-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.

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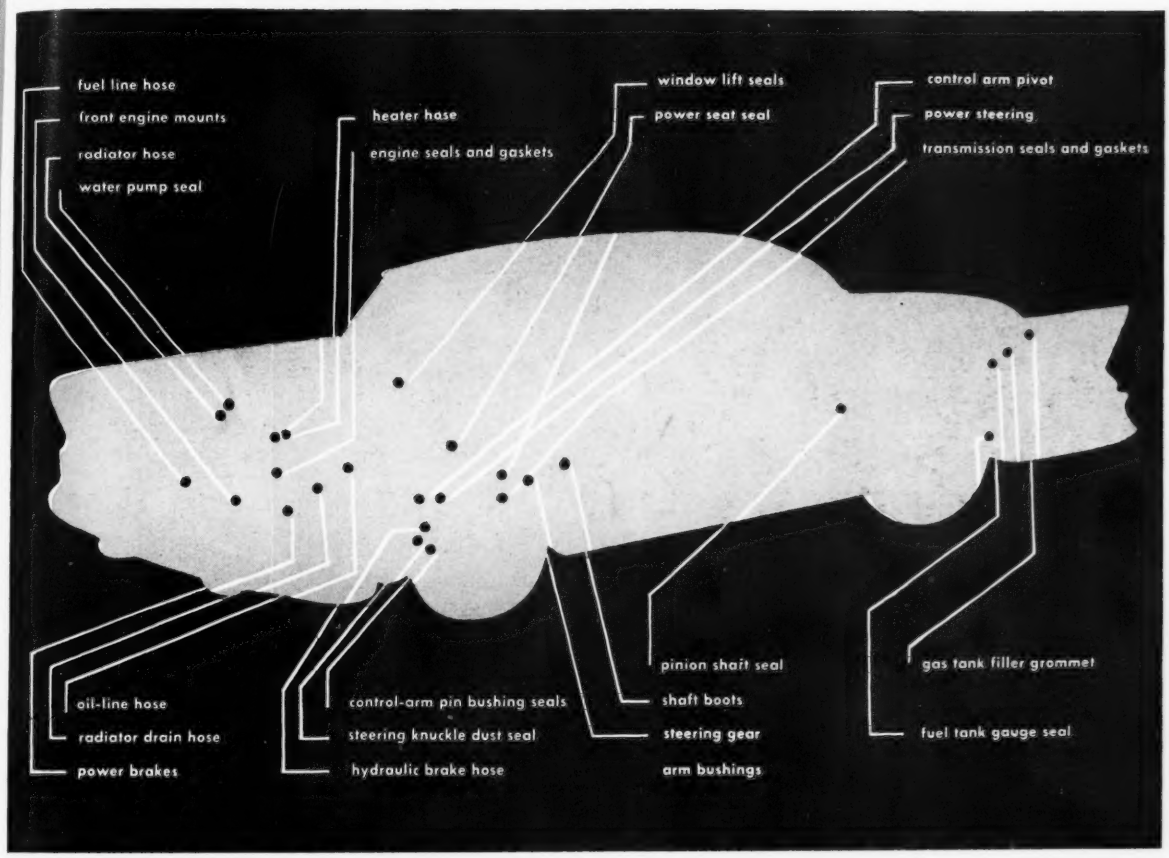
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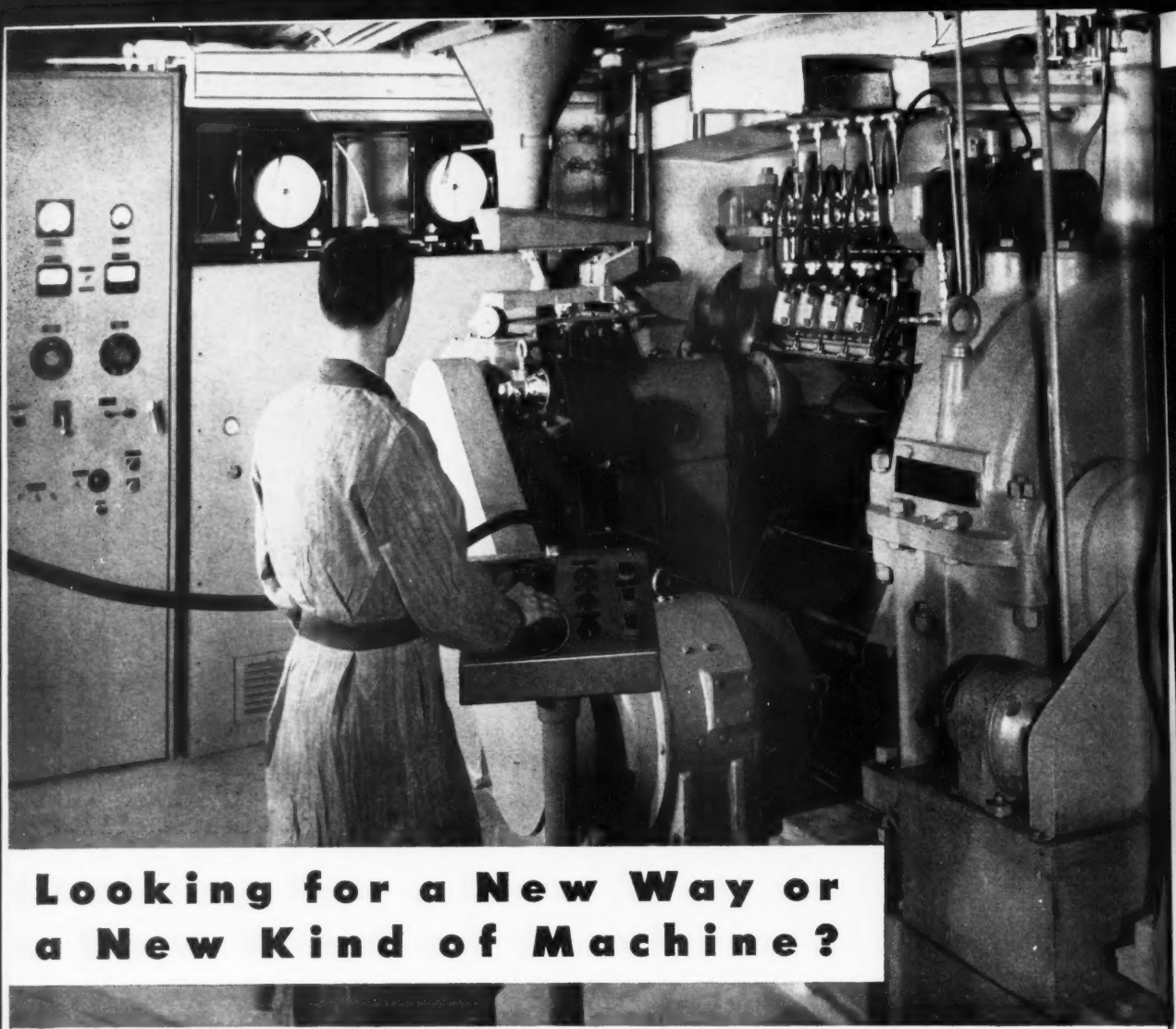
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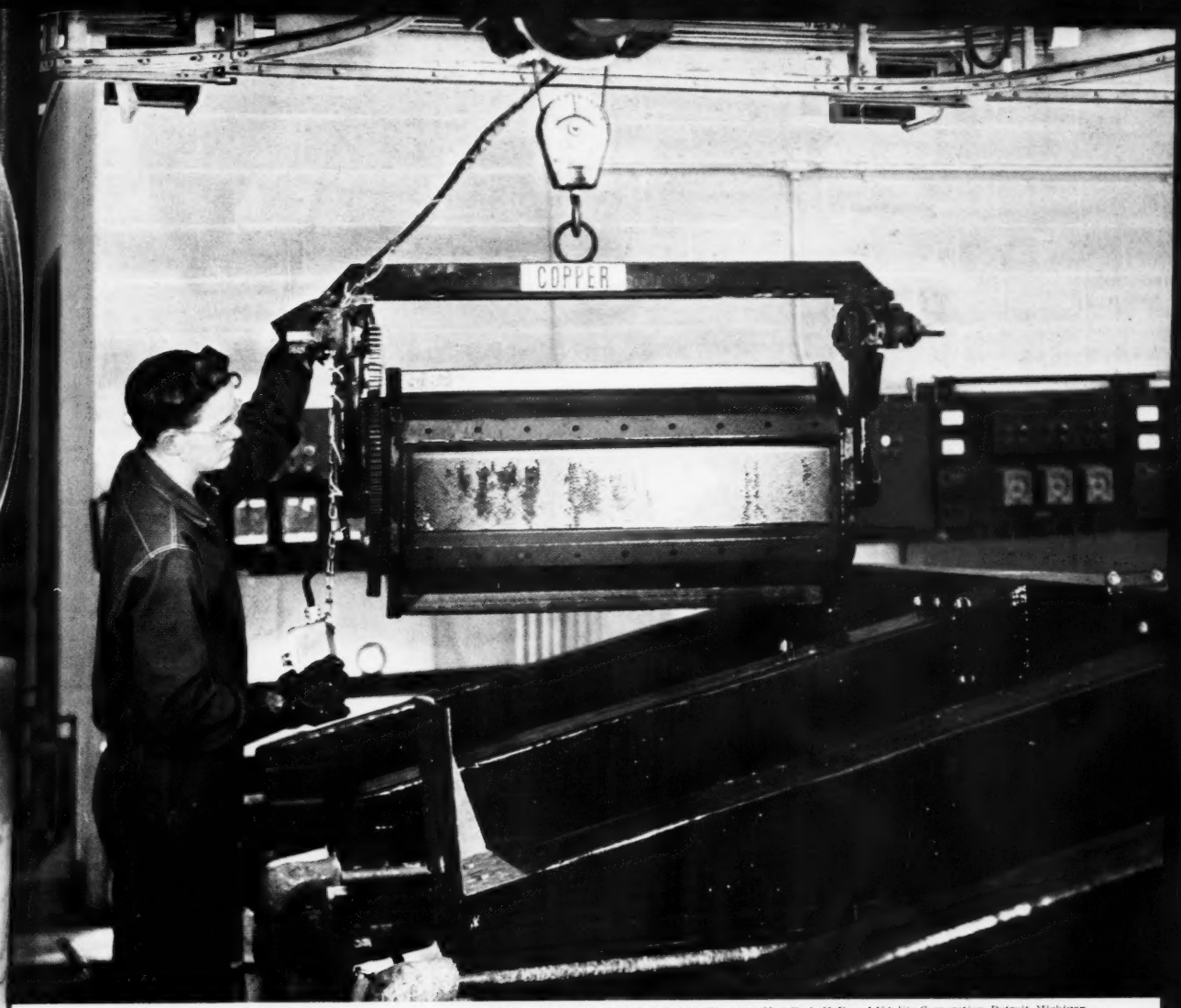


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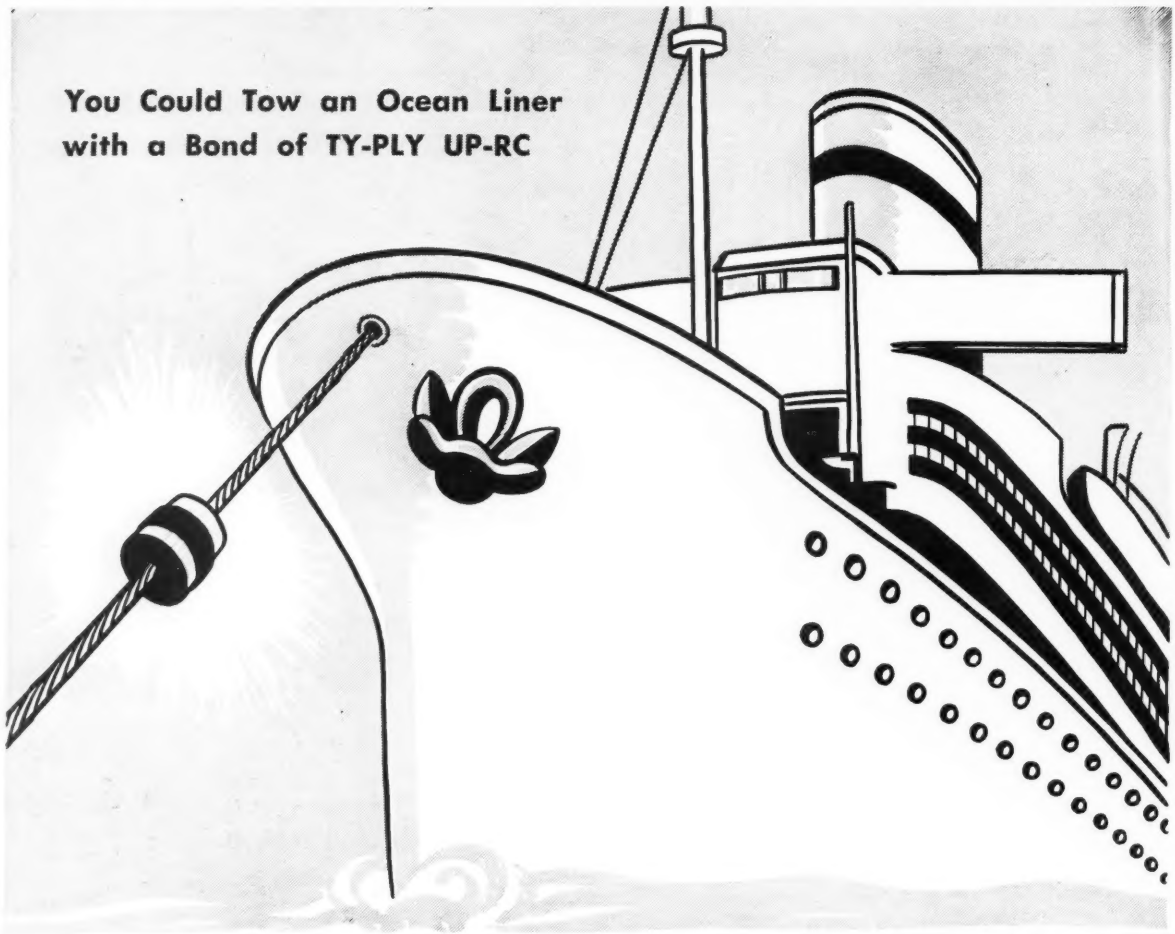
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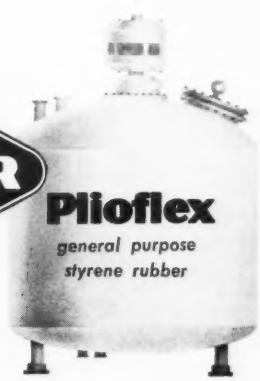
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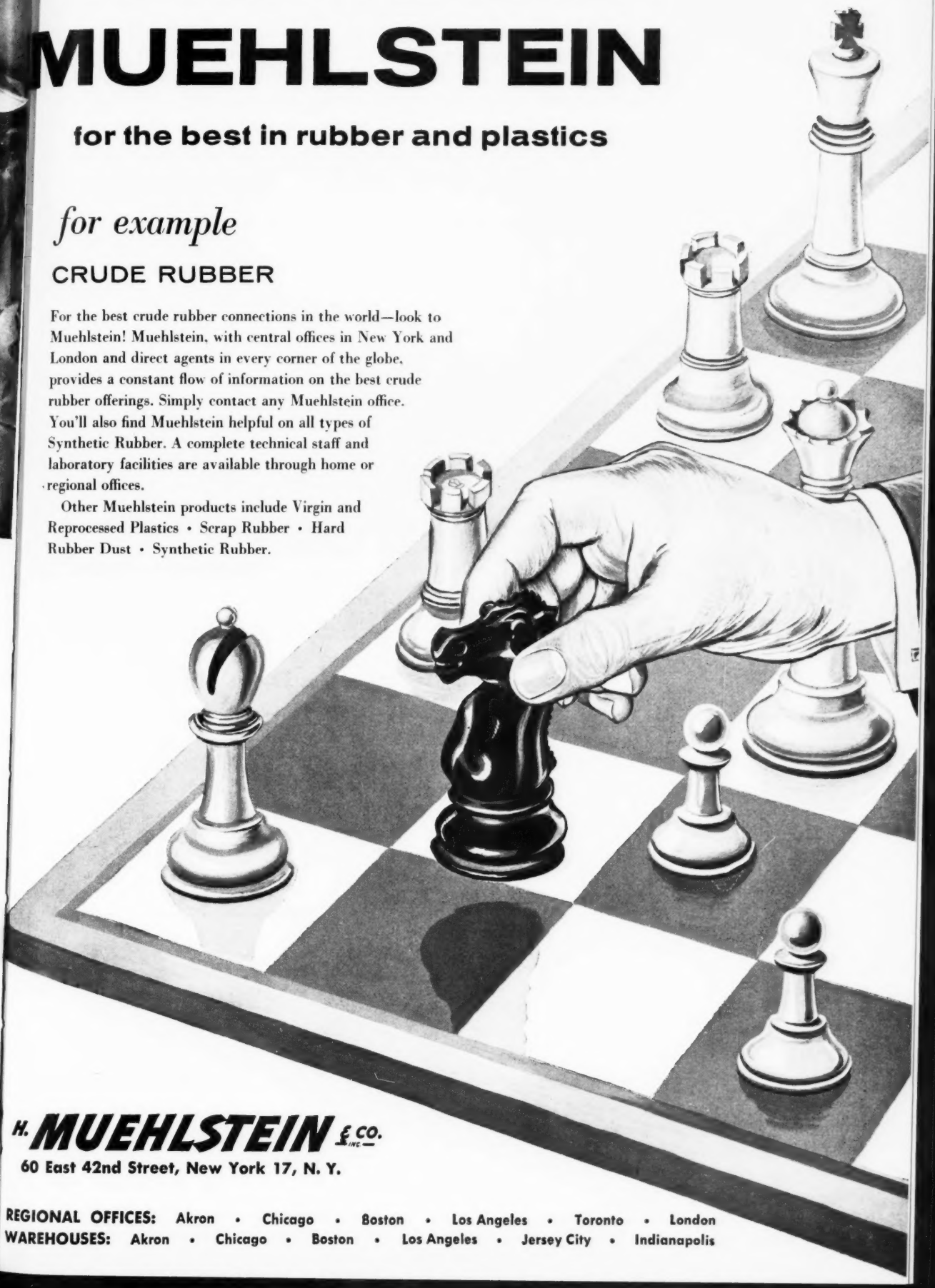
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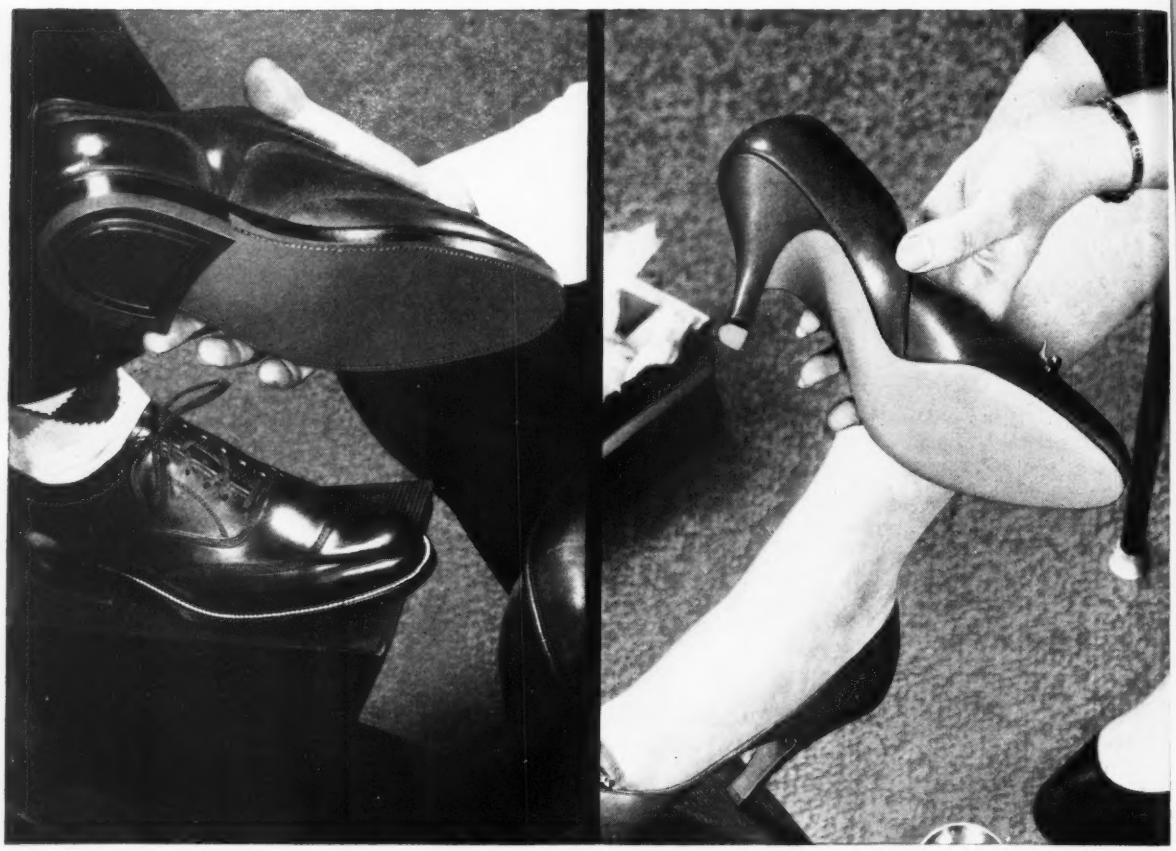


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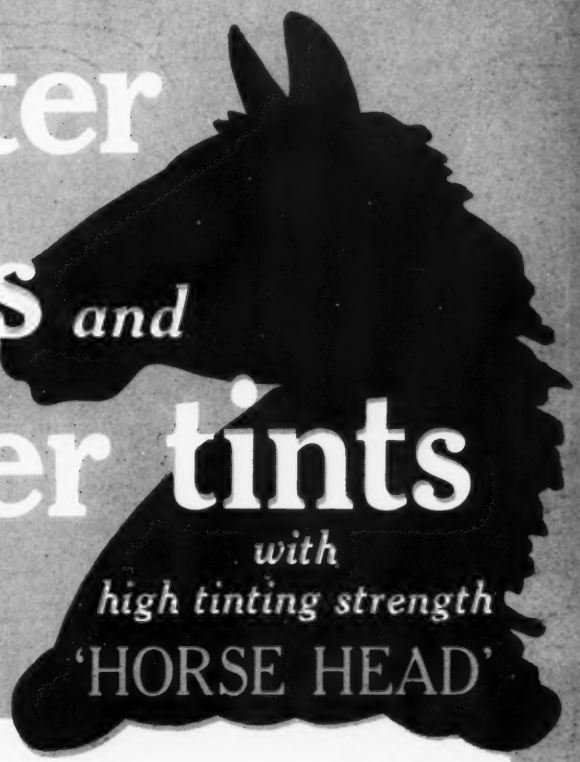
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THE NEW JERSEY ZINC COMPANY

Founded 1848

160 Front Street, New York 38, N. Y.

BOSTON CHICAGO CLEVELAND OAKLAND LOS ANGELES

Also Distributed by

VAN WATERS AND ROGERS

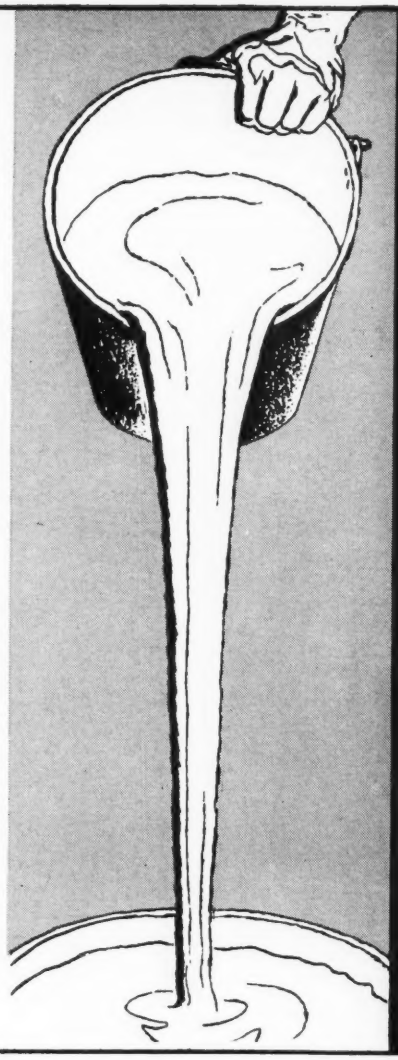
SEATTLE PORTLAND (ORE.) SPOKANE VANCOUVER, B. C. DALLAS HOUSTON

ST. LAWRENCE CHEMICAL COMPANY, LTD.

TORONTO, ONT. MONTREAL, QUE.

HORSE HEAD PRODUCTS

It's inert to hydrolysis and bacterial action...



the thickener that pours easily!

MODICOL® VD LATEX THICKENER

A SYNTHETIC POLYMER

You're likely to find an ideal combination of advantages when you thicken latex with Modicol VD. For this synthetic polymer gives uniform high viscosity . . . smooth and gel-free . . . even at very low concentrations.

Modicol VD pours easily, saves you time, guesswork and material waste.

Modicol VD not only eliminates creaming and separation but also improves mechanical stability of the latex emulsions. These are all typical advantages. Why not find out how Modicol VD can help improve your own processing. Simply send today for bulletin MVD 33 to Nopco Chemical Company, Harrison, N. J.

Advantages of MODICOL VD

Easy to handle
High uniform viscosity at low concentrations
Smooth gel-free type of viscosity
Stable in alkaline fluids
Unaffected by bacteria or fungi

NOPCO

PLANTS: Harrison, N. J.
Cedartown, Ga. • Richmond, Calif.
London, Ont. Canada



is a nasty word to rubber!

Ozone cracking in rubber is expensive, in sales lost and user dissatisfaction. Protect your rubber products from this danger with Universal's high potency antiozonants, UOP 88 and UOP 288.

Developed by Universal, these antiozonants have proven that they can provide complete protection to tires, or other rubber products under both dynamic and static exposure.

We'll be glad to recommend the best UOP 88 or 288 formulation to protect your product from ozone cracking and help it maintain the appearance and the service built into it.

UOP 88® and 288
TRADEMARK
RUBBER ANTIOZONANTS

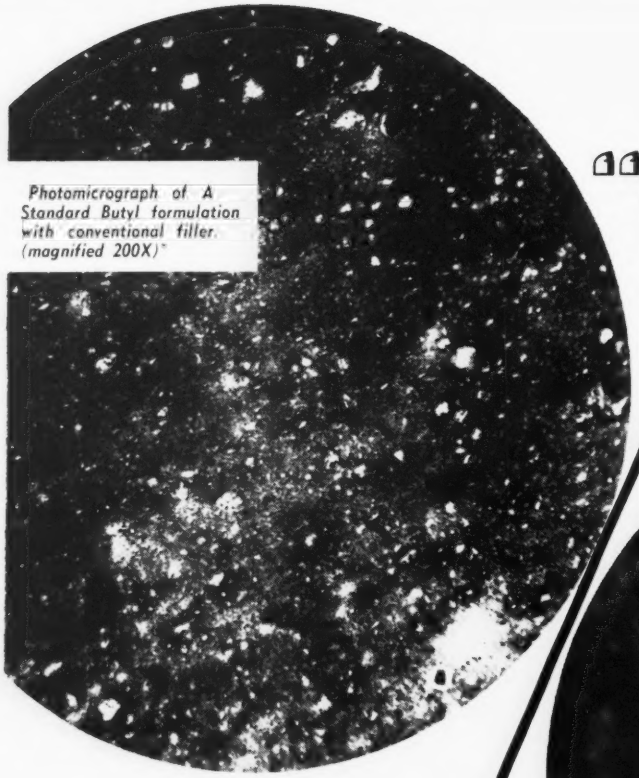
UOP®

PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U. S. A.

Burgess "ICECAP K" for



*Photomicrograph of A Standard Butyl formulation with conventional filler. (magnified 200X)**



*Same formulation using Burgess "Icecap K" filler. (magnified 200X)**

SUPERIOR BUTYL RUBBER COMPOUNDS FREE FROM AGGLOMERATES

Burgess offers a more uniform calcined kaolin pigment —*free from agglomerates!* Especially useful in Butyl Wire & Cable Insulating Compounds, "Icecap K" offers excellent processing, reinforcing, and electrical properties.

Technical data, working samples and prices, upon request.

features:

- Nil screen residue with 325 mesh screen
- Better dispersion
- Freedom from agglomerates
- Increased tensile strength
- Good electrical properties
- Low moisture absorption
- Superior curing and processing properties
- Top reinforcing qualities
- Excellent alkali and acid resistance

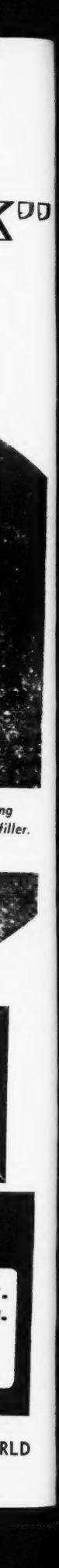
**Torn section of a 1/16" slab*

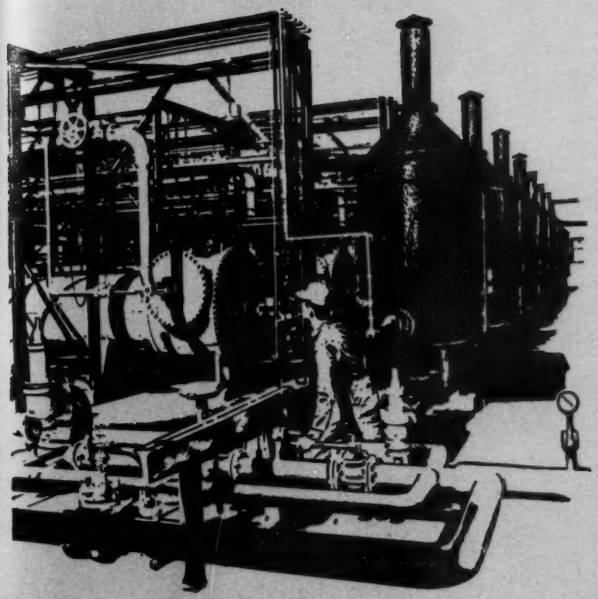
Burgess Pigment COMPANY

Mines and Plants: Sandersville, Georgia

EXECUTIVE SALES OFFICES: P. O. BOX 145, SANDERSVILLE, GA.
West Coast: L. H. Butcher Co., San Francisco & Los Angeles, Cal.
Warehouses: Jersey City & Trenton, N. J.; Saylesville, R. I.

- **HYDROUS AND ANHYDROUS ALUMINUM SILICATE PIGMENTS**
- **KAOLIN CLAYS**

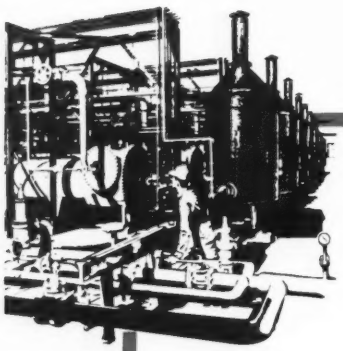




QUALITY

PERFORMANCE

UNITED CARBON BLACKS



KOSMOS 70

KOSMOS 70 ISAF is the ideal black for many applications. It is widely favored in natural and synthetic rubbers for tread stocks and camelback. It does well in processing and imparts exceptional reinforcement, improved tread wear, and better resistance to cracking.

THESE QUALITIES have brought a high demand for Kosmos 70 for toughest treads, maximum mileage tires, and for gruelling high-speed highway operations.

KOSMOS 70 and the other fine carbon blacks bearing the UNITED trademarks are made to meet the highest standards. Their excellence is recognized everywhere.

UNITED CARBON COMPANY, INC.

A subsidiary of United Carbon Company

CHARLESTON 27, WEST VIRGINIA

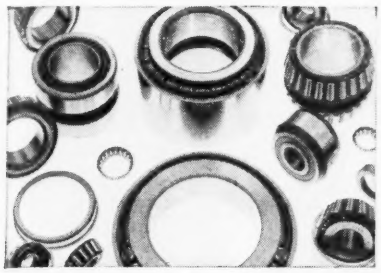
NEW YORK
BOSTON

AKRON
LOS ANGELES

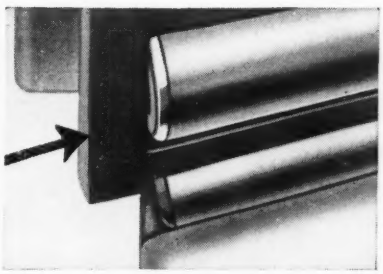
CHICAGO
MEMPHIS

IN CANADA: CANADIAN INDUSTRIES, LTD.

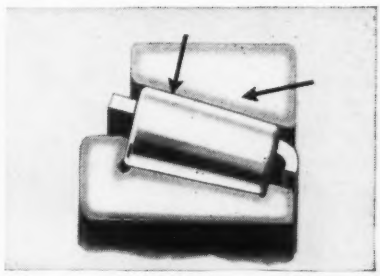
Get all these advantages . . . specify TIMKEN® tapered roller bearings



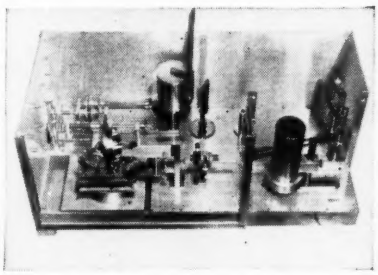
THERE ARE 27 TYPES of Timken® tapered roller bearings. This wide selection means you get the bearing design exactly suited to your job. Whatever your bearing application problem, we can help solve it.



THE SOFT STEEL CAGE used in Timken tapered roller bearings separates the rollers, keeping them spaced evenly. This prevents scuffing of the rollers, adds to the bearing life and gives you more for your money.



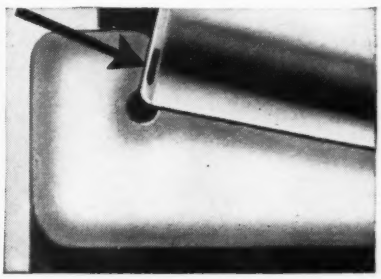
HARD ON THE OUTSIDE, tough on the inside. To take shock loads, give longer life, Timken bearing rollers and races are case-carburized to have a hard, wear-resistant surface over a tough, shock-resistant core.



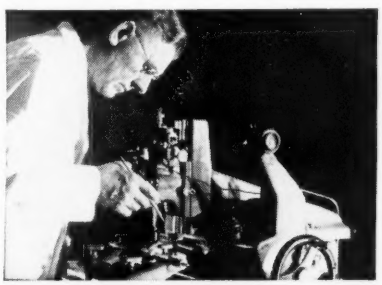
MICRO-INCH FINISH is standard for Timken bearings. This profilograph checks contours and smoothness of circular surfaces to a millionth of an inch, helps us make Timken bearings truer, quieter, longer-wearing.



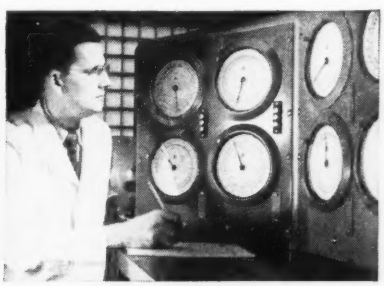
6,525 SIZES, the world's largest selection of tapered roller bearings. From bearings smaller than your finger to 71½" in inside diameter, the Timken Company can supply the size you need for any specific application.



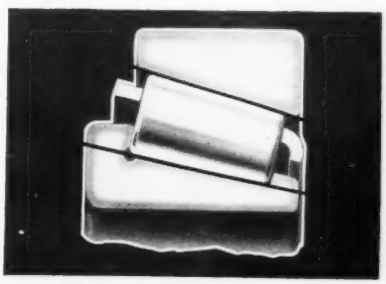
POSITIVE ROLLER ALIGNMENT is assured because the taper in Timken bearings holds ends of rollers snug against the rib. The taper in Timken bearings lets them take radial or thrust loads or any combination.



ACCURATE TO 50 MILLIONTHS of an inch. This Universal Measuring Machine checks gages and machine parts used to make Timken bearings. Our gage laboratory, one of the world's best equipped, helps make Timken tapered roller bearings your No. 1 bearing value.



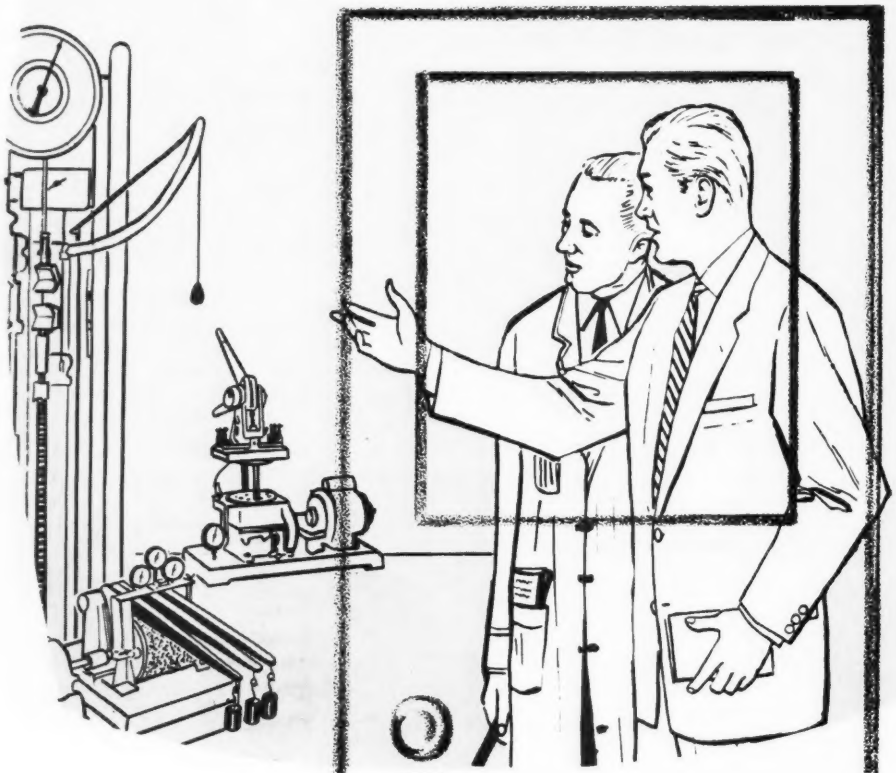
WE MAKE OUR OWN FINE ALLOY STEEL. No other American bearing maker does. This spectrometer helps control steel quality—in 40 seconds gives the exact chemical analysis of a melt. In a few minutes, results are flashed to the melter. It's another step in rigid quality control.



FULL LINE OF CONTACT between Timken bearings' rollers and races gives them *extra* load-carrying capacity. To get *all* these advantages, specify "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.



Where Successful Reclaims Start . . .

At Pequanoc Rubber Company, there is a very important door with a very special shingle. It reads, "Technical Service Department."

Behind this door, men of experience in producing special formulas in reclaimed rubber for over 55 years, have been helping Pequanoc's customers cut costs with quality reclaim.

This department is responsible for perfecting highly uniform reclaims which provide trouble-free operation.

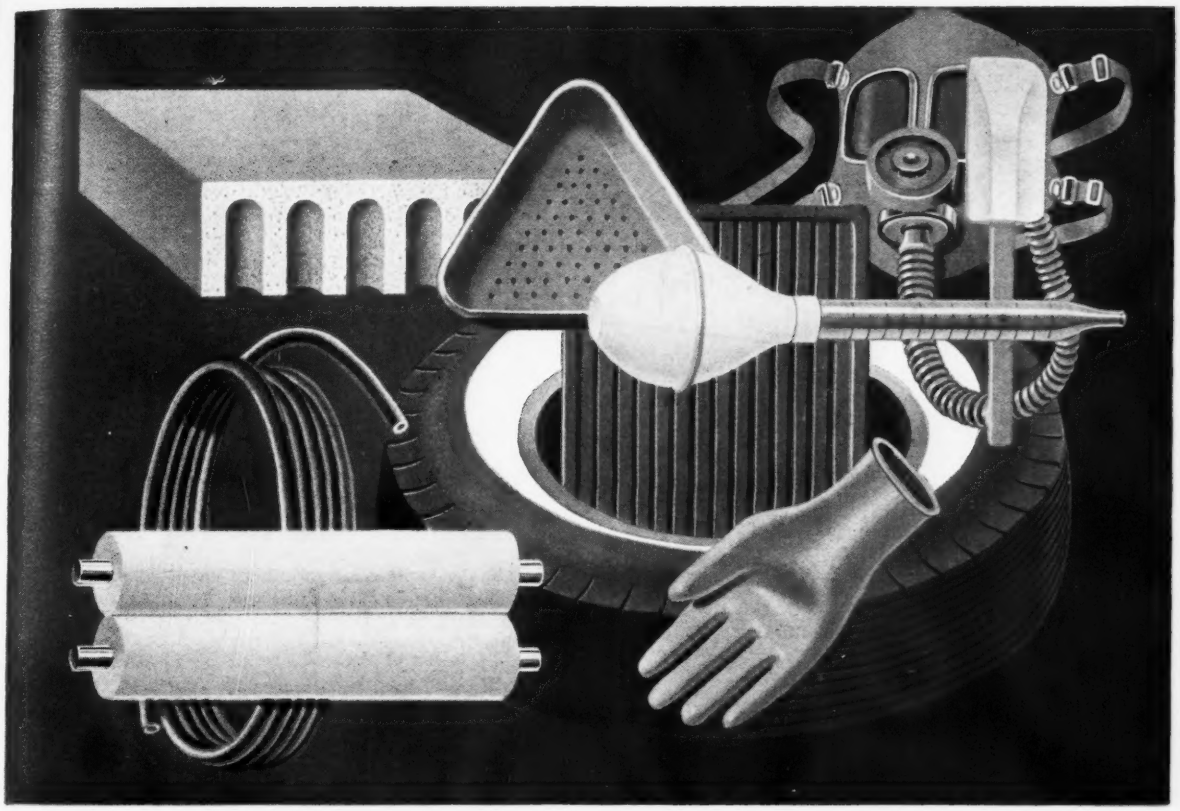
Superior quality and low cost can be blended into your product. Let the men behind the door *"where successful reclaims start"* assist you.

Inquire today.

Pequanoc Rubber Co.

MANUFACTURERS OF RECLAIMED RUBBER

MAIN SALES OFFICE and FACTORY: BUTLER, N. J.



You'll find Nevastain B is a superior non-staining antioxidant at lower cost

Nevastain B is an excellent non-staining, non-discoloring antioxidant developed especially for rubber manufacturers who prefer an antioxidant in the flaked form for greater convenience in compounding operations. It is shipped in sturdy 50-pound bags for easy weighing and handling. *In some instances, Nevastain B can replace products three times higher in cost,* and it has proved itself to be readily compatible with synthetic and natural rubbers, has shown no indication of blooming at more than double normal dosage, and does not interfere with the rate of cure. Write for a sample and the Technical Service Report on Nevastain B.

Neville Chemical Company, Pittsburgh 25, Pa.

Resins—Coumarone-Indene, Heat Reactive, Phenol Modified Coumarone-Indene, Petroleum, Alkylated Phenol • **Oils**—Shingle Stain, Neutral, Plasticizing, Rubber Reclaiming • **Solvents**—2-50 W Hi-Flash, Wire Enamel Thinners, Nevsolv.

NEVILLE

Please send Technical Service Report on Nevastain B.

NAME TITLE

COMPANY

ADDRESS

CITY NC3CRW STATE

FOR MAXIMUM SUN-CHECKING PROTECTION

Specify Original Formula

"ANTISUN"*

by

CARY

*Registered Trade Mark



- Recommended usage: 2-4% of the weight of the rubber hydrocarbon, depending on the degree of protection desired.
- Unlimited Availability.
- Low Cost.
- Available in convenient chipped or slabbed forms.

Maximum protection against sun-checking over extended periods can only be guaranteed when a top-notch sun-checking agent is employed.

Cary "Antisun",

formulated of the finest quality ingredients and proven so satisfactory in tire compounding, mechanical goods, insulated wire and cable compounds, is still the same basic formula developed by our President years ago.

Accept no substitute for this time-tested, highest quality product — CARY "ANTISUN".

Cary Chemicals Inc.

P. O. BOX 1128, NEW BRUNSWICK, NEW JERSEY
Laboratory and Plant: RYDERS LANE, MILLTOWN, NEW JERSEY
CHarter 9-8181

CARY CHEMICALS PRODUCTS:

- Vinyl Plasticizers
- Vinyl Compounds
- Sun Checking Waxes
- Gilsonite Compounds
- Reclaiming Oils
- High Melting Point Synthetic Waxes
- Tall Oil Esters

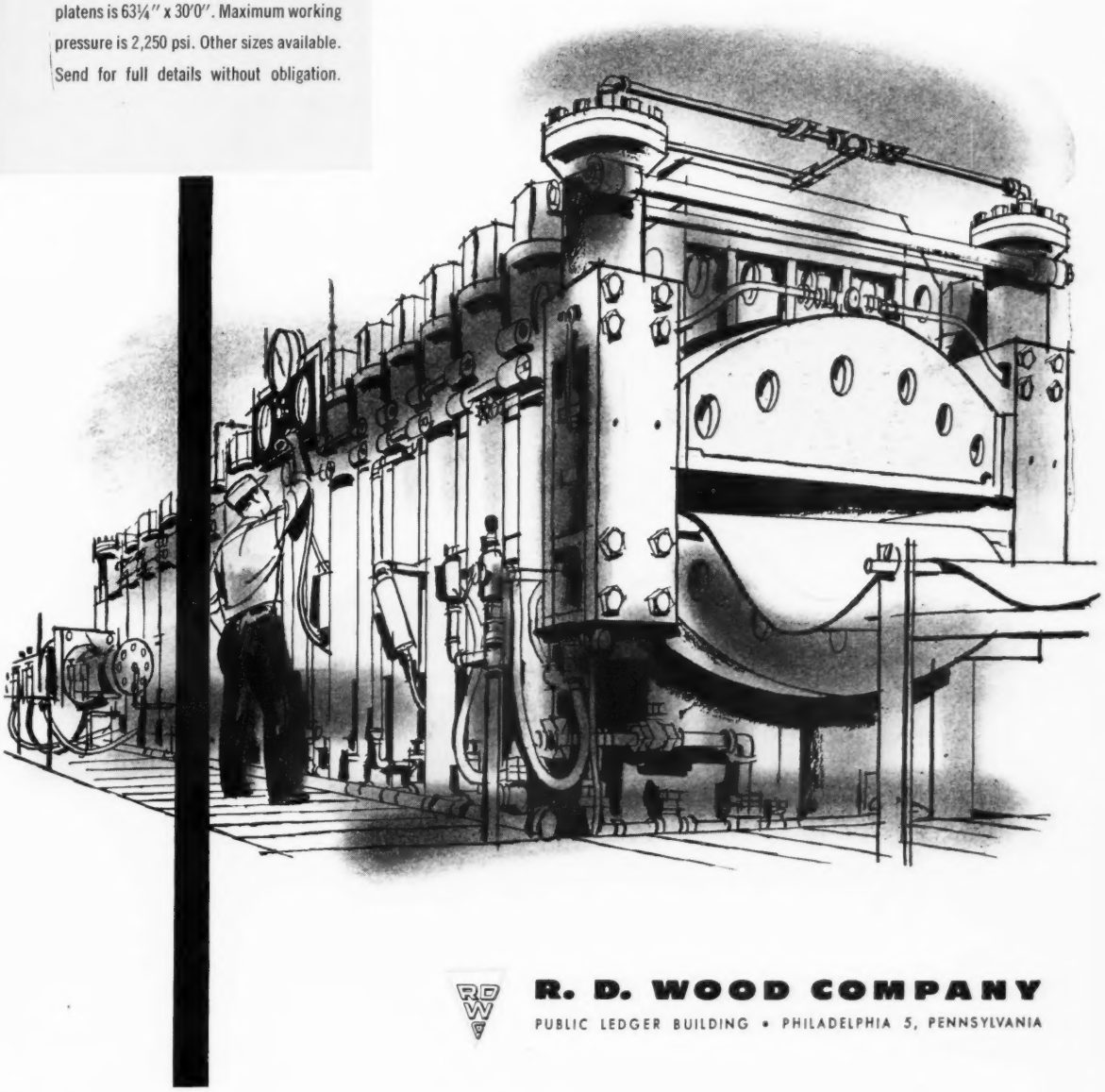
Canadian Representative: Lewis Specialties, Ltd., 1179 Decarie Blvd., Montreal 9, Que.

The standard by which other presses are judged



Single Opening Belt Press for vulcanizing rubber belting. Press is equipped with hydraulic stretcher and clamping units mounted at the ends of the moving platen. Press capacity is 3,180 tons. Size of heating platens is 63¼" x 30'0". Maximum working pressure is 2,250 psi. Other sizes available. Send for full details without obligation.

The proof of any press is its performance; excellence invariably shows up in service. How to be sure of quality when you choose a press? Simply look for the name 'R. D. Wood' on the nameplate. In every R. D. Wood Press, sound design, select materials, skilled craftsmanship combine to give you over-all efficiency, operating ease, production economy and long service. Write for engineering data on R. D. Wood Presses for the rubber industry.



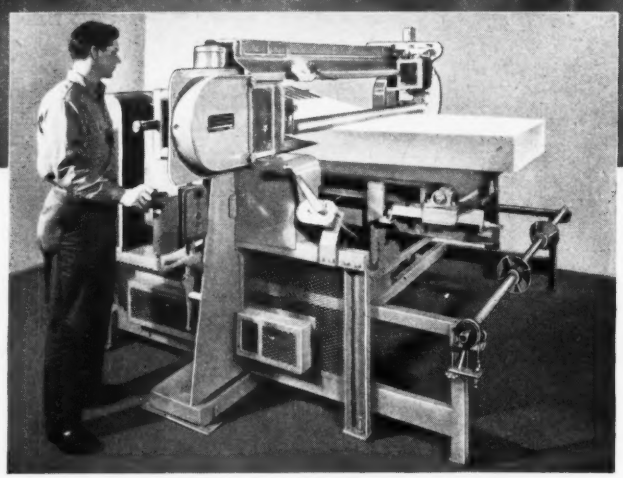
R. D. WOOD COMPANY

PUBLIC LEDGER BUILDING • PHILADELPHIA 5, PENNSYLVANIA

Now at Your Service!

FEMCO CUSTOMER SERVICE CENTER





FEMCO announces new facilities for Customer Service — **a building entirely devoted to and fully equipped for test cutting your materials on our machinery *without obligation to you!***

Above and at right are views of equipment we have already installed in our Customer Service Center. Customer Conference Rooms and Staff Offices for our Service Department people are also part of our new facilities to serve you better.

Our machines will die cut, split, shape or trim Polyvinyl Chloride Foams, Polyurethane, Plastics, Latex Bonded Foam, Molded Rubber Goods, Rubberized Hair, Cellulose Sponge, Cork, Resin Bonded Fiber, Wood Fiber, Fiberglas, etc., in rolls, sheets or slabs.

Send us any material you want to split, shape, trim or die cut. We'll test cut the samples and you'll get a prompt, complete report on what our machines can do. There is no obligation.

REMEMBER — if you have a stock cutting or splitting problem, we're here to help you. Just call on us.

1917 40th ANNIVERSARY 1957

The FALLS ENGINEERING AND MACHINE CO.

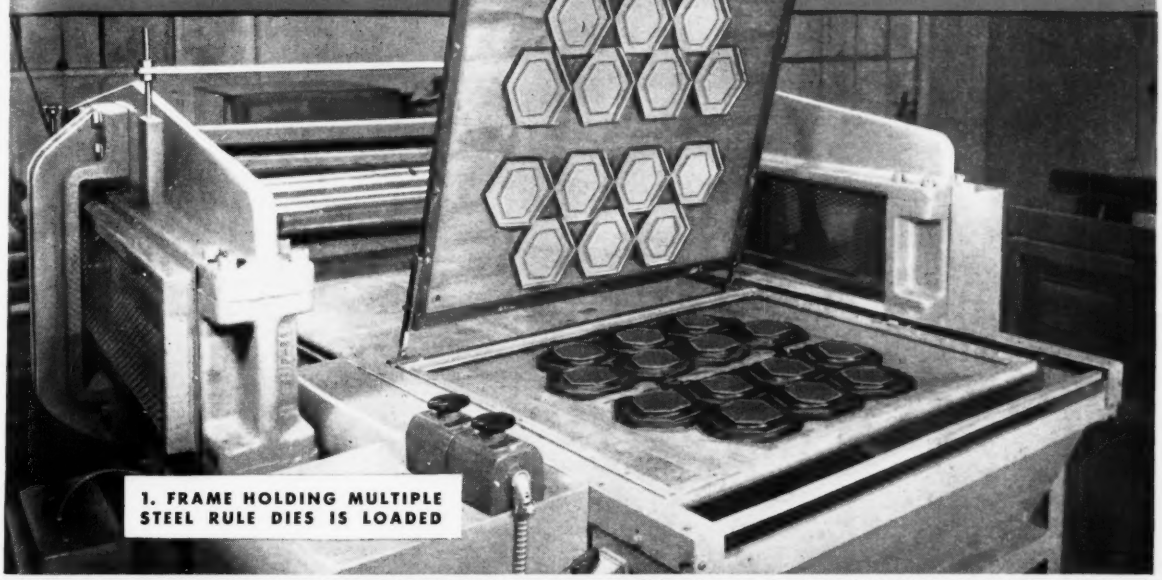
Established 1917

1734 FRONT ST., CUYAHOGA FALLS, O.

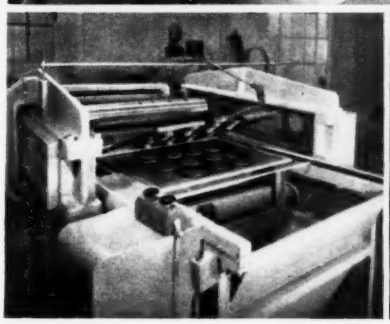
FEMCO'S V-BELT EQUIPMENT

includes Collapsible and Ring Molds, Curing Cages, Autoclave Type Belt Molders, Hydraulic and Manual Manipulators, Vertical and Horizontal Type Measuring and Matching Machines, Notching Machines, the new and improved V-Belt Skiving Machine, and a new and improved V-Belt Collapsible Building Drum. Call us first for this equipment.

How FEMCO'S new loading and unloading Roller Die SAVES TIME and CUTS COSTS FROM MULTIPLE CURING MOLD TO FINISHED DIE CUT PRODUCT



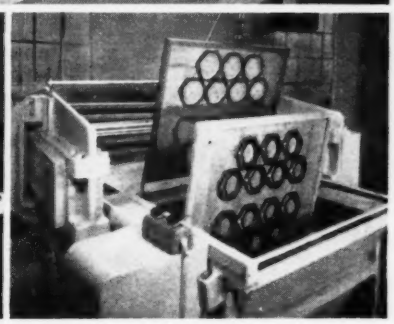
1. FRAME HOLDING MULTIPLE STEEL RULE DIES IS LOADED



2. MOVES ONTO DIE CUTTER BED



3. PARTS ARE CUT



4. THEY DROP INTO TOTE BOX

This is FEMCO's new automatic Loading and Unloading Heavy Duty Roller Die Cutter. The four pictures, top and bottom, show the four time-saving operating steps from multiple cavity curing molds to the finished die cut product.

FEMCO's new equipment was designed particularly for production die cutting and trimming of molded rubber goods, including small automotive rubber parts such as brake and accelerator pedals, spring pads, etc.

The first saving comes when the mat or sheet of cured molded rubber stock is placed on a multiple steel rule die loading frame *without trimming or cutting the mat.* The fully loaded frame moves automatically onto the bed of the die cutter, and the stock is die cut and trimmed in one operation. Finished parts drop in a tote box for inspection, simply by turning the frame.

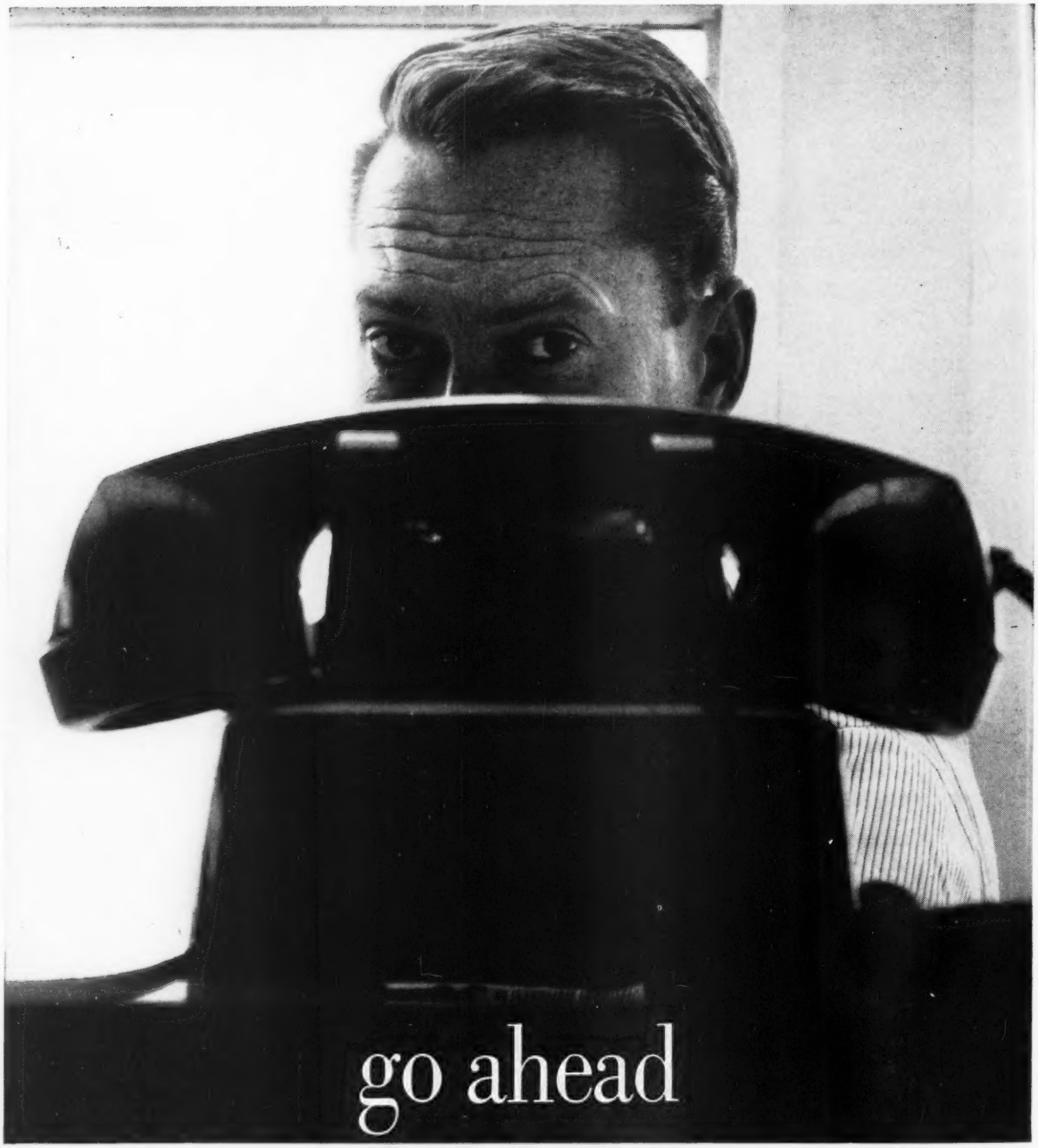
This equipment fits Die Cutters with bed sizes 48 x 42, 48 x 72, and 48 x 84. On the two larger size machines the equipment may be attached to each end of the Die Cutter, producing a continuous die cutting process, if desired.

Write, wire or call Falls Engineering and Machine Co. now for full details and prices.

1917 40th ANNIVERSARY 1957

The FALLS ENGINEERING AND MACHINE CO.

CUYAHOGA FALLS, O.



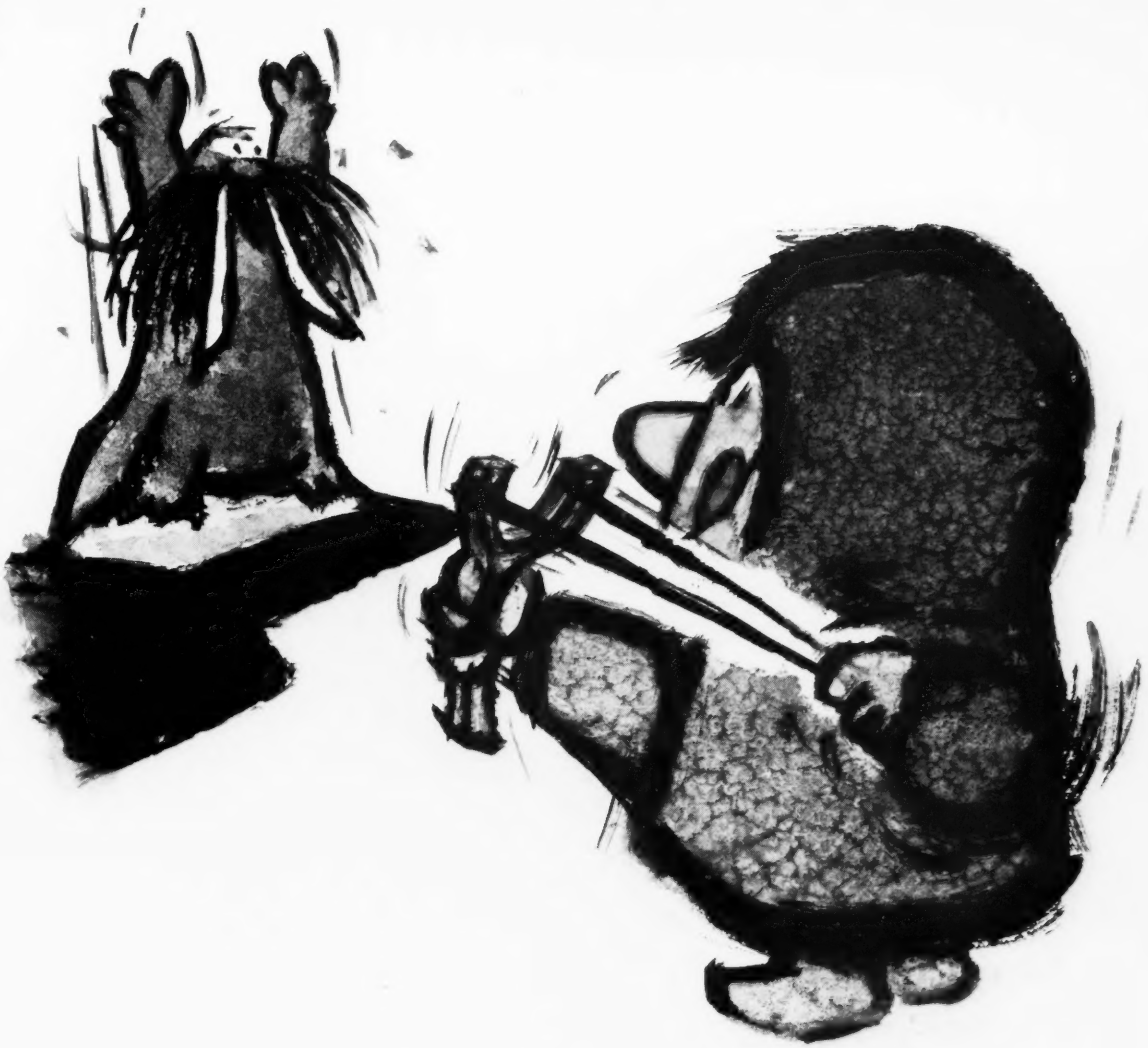
CALL!

the fastest cure for worry about cancer: a call to your doctor now!

Scared? You shouldn't be! Look at it this way. The average man who walks into the doctor's office walks out floating. That lump that was so frightening . . . nothing to worry about at all! The sky's bluer, the air's sweeter, it's a great big beautiful day . . . because he picked up that phone and called!

It happens all the time. It can happen to *you*. "Sure," you say, "but just supposing"... OK. Let's look at the facts. In past years, we were saving 1 out of 4 cancer patients. Today, we're saving 1 in 3. And the odds could get better still . . . if *people would call their doctors in time!*

So go ahead...call. See your doctor now. And after your checkup—how about a check for the American Cancer Society? Every dollar sends us further along the road to cure. And when *that* happens . . . it's going to be a wonderful day for us all! Send your check to "Cancer" in care of your local Post Office.



COPO

means pioneering in cold rubber...

We are COLD RUBBER specialists and the name COPO represents not only high quality general purpose types of COLD RUBBER but also means pioneering in the development of products for special applications. Prominent among these is COPO 1505, which is COLD RUBBER especially designed for products which must function under frigid conditions. Why not let us furnish you with additional information.

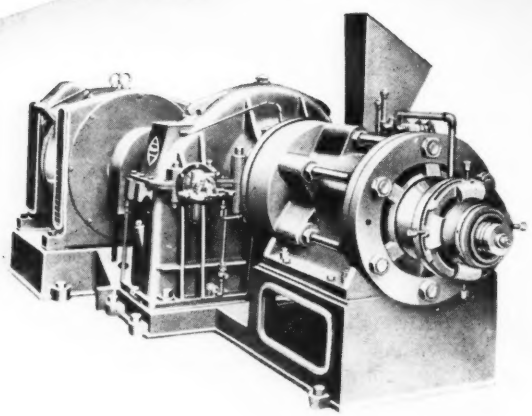
uniformity • good service • high quality • well-packaged

COPOLYMER RUBBER & CHEMICAL CORPORATION • BATON ROUGE 1, LOUISIANA COLD RUBBER SPECIALISTS

QUALITY EXTRUSION

QUALITY ENGINEERING FOR QUANTITY PRODUCTION

RI
2
3
4½
6
8
10
12



Variable speed drives, carefully designed flow channels. Heat extraction and accurate temperature control are precision features of Shaw design which promote quality products at high production rates. Piping, tubing, miscellaneous sections and sheathing and insulating of cables are adequately catered for by the wide selection of die-heads available. Francis Shaw & Co. Ltd. supply a unique range of plant for the Rubber and Plastic Industries. Enquiries are invited for layout suggestions and arrangements most suitable for your particular requirements.

SHAW

RANGE OF EXTRUDERS

FRANCIS SHAW (CANADA) LTD GRAHAMS LANE BURLINGTON ONTARIO CANADA

TELEPHONE NELSON 4-2350 TELEGRAMS CALENDER BURLINGTON ONTARIO

FRANCIS SHAW & COMPANY LIMITED MANCHESTER II ENGLAND

TELEPHONE EAST 1415-8 TELEGRAMS CALENDER MANCHESTER TELEX 66-357

P4477



But we are talking about OTHER KINDS OF MIXES-

For Instance in such applications as: In general rubber compounding for plasticizing, extending, tackifying and stiffening; or in softening compounds for drug sundries and toys; or for soles and heels, floor tile, belting and gaskets . . . And in many other applications of laminating, sizings for textiles and leather, impregnating, insulating, adhesive making, coating . . .

PICCOUMARON

Para Coumarone Indenes

Neutral inert synthetic resins that promote good aging, good flexing, high tear resistance.

PICCOLYTE

Pure Hydrocarbon Terpenes

Thermoplastic synthetic resins having the same carbon to hydrogen ratio as plantation rubber. Chemically inert, non-toxic.

PICCOLASTIC

Styrene & Modified Styrenes

Thermoplastic, light colored synthetic resins completely soluble in aromatic hydrocarbons.

PICCOPALE

A Basic Raw Material

Low-cost thermoplastic synthetic resins that can serve as a basic raw material for many applications.

RESINEX

Liquid, Flake or Solid

A versatile aromatic resin of a thousand uses—in GR-S, natural, reclaim, neoprene, vinyls and other thermoplastics.

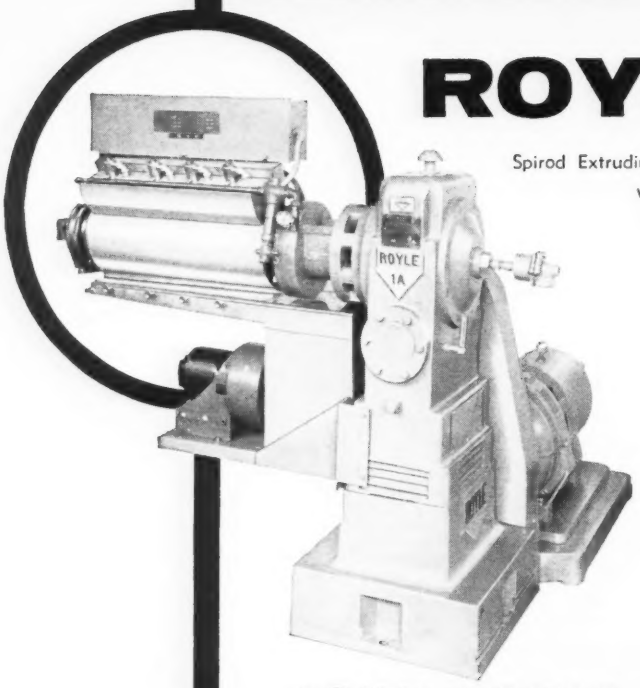
Write for complete technical data on resins
PICCO Resins are manufactured by Pennsylvania Industrial Chemical Corp.

HARWICK STANDARD CHEMICAL CO.

60 SOUTH SEIBERLING STREET, AKRON 5, OHIO

BOSTON 16, MASS. 661 BOYLSTON STREET
TRENTON 9, NEW JERSEY 2595 E. STATE STREET
CHICAGO 25, ILLINOIS 2724 W. LAWRENCE AVE.
LOS ANGELES 21, CALIF. 1248 WHOLESALE STREET
ALBERTVILLE ALA. OLD GUNTERSVILLE HWY.

ROYLE 1A (2½" cylinder bore)



Spirod Extruding Machine with electric heating and high velocity evaporative cooling. An all-purpose extruding machine for processing rubber and plastics. Available in sizes 1⅛" through 12" cylinder bore.

Strainers, Cooling Troughs, Light Wire and Cable Capstans, Motorized Take-ups, Temperature Control Units.

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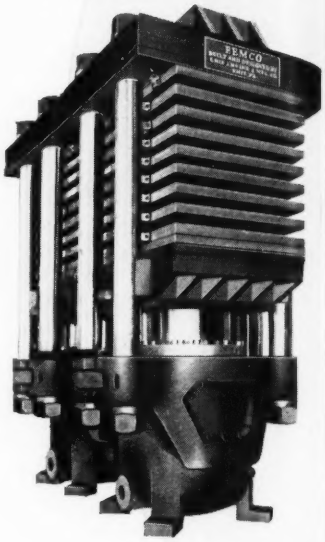
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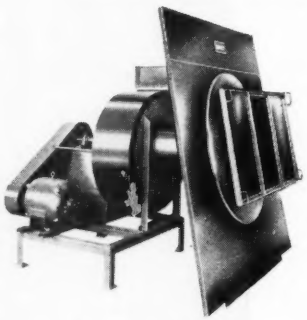
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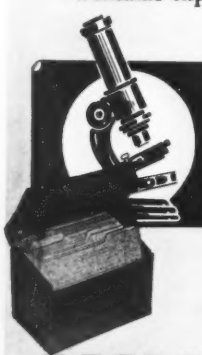
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NEW DEVELOPMENT

Monsanto in collaboration with Esso research has developed a new product that increases the modulus and resilience of butyl rubber—*under standard processing conditions.*

This new concept in butyl modification involves a reaction of the butyl rubber with a chemical additive, N-methyl-N, 4-dinitrosomethyl aniline—trade-named by Monsanto: Elastopar. Adding Elastopar to the Banbury creates a chemical modification of the butyl polymer. You get this modification *using normal times and temperatures of mixing.*

Elastopar is effective in both black-loaded and non-black butyl rubber stocks. It is non-scorching. Elastopar actually aids processing. The modified butyl may be cured with conventional vulcanizing systems.

LOTS OF APPLICATIONS POSSIBLE

As soon as you take two pieces of stock in your hands, one modified with Elastopar, one not—you can quickly feel the improved resilience and snap.

Improved resilience is just one advantage. Here's a quick run-down on other ways Elastopar improves the properties of butyl:

- Vast increase in modulus.
- No increase in hardness.
- Raises resistance to abrasion.
- Lowers low-temp flexibility.
- Increases electrical resistivity in carbon black systems roughly from 10^6 to 10^{14}.
- Reduces cold-flow of uncured stocks.
- Lowers Mooney viscosity.
- Does not affect cure.

NEW MARKETS FOR BUTYL

One significant effect in the end-product: Elastopar checks the tendency of early experimental butyl tires to develop excessive heat from absorbed road shocks.

But of more immediate interest—the excellent solvent resistance, gas retention, and high dielectric properties of butyl can be put to use in cable coating, automotive "air springs," gaskets, and mechanical goods. For more information on how Elastopar can help you build-in new profit-making properties in butyl, call or write today.

Accelerators—*For fast, slow, and regulated rates of safe cure.*

Antioxidants—*For maximum oxidation resistance.*

Plasticizers

Specialty Processing Compounds



You can *feel* the difference instantly—but watch! Stock at right, unmodified butyl. At left, modified with Elastopar. See what happens.



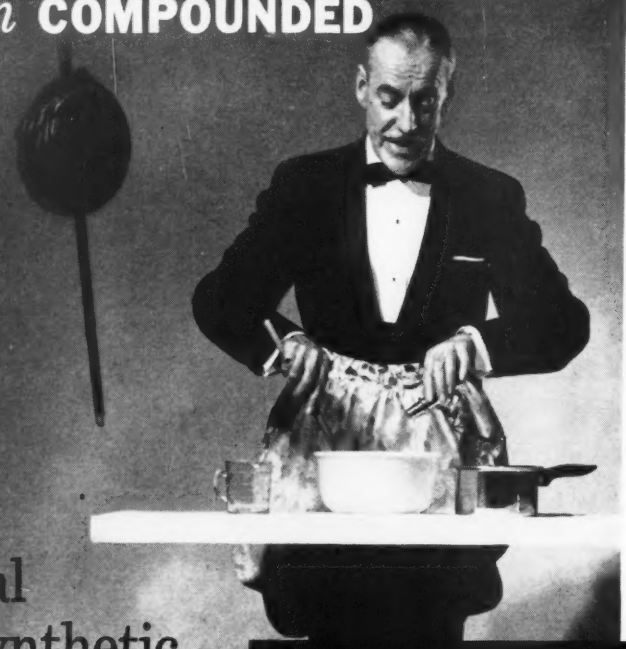
Sample modified by Elastopar, left, flattened completely in 3 seconds. This new resiliency is just one of nine valuable properties butyl rubber offers when *chemically* modified with Elastopar.

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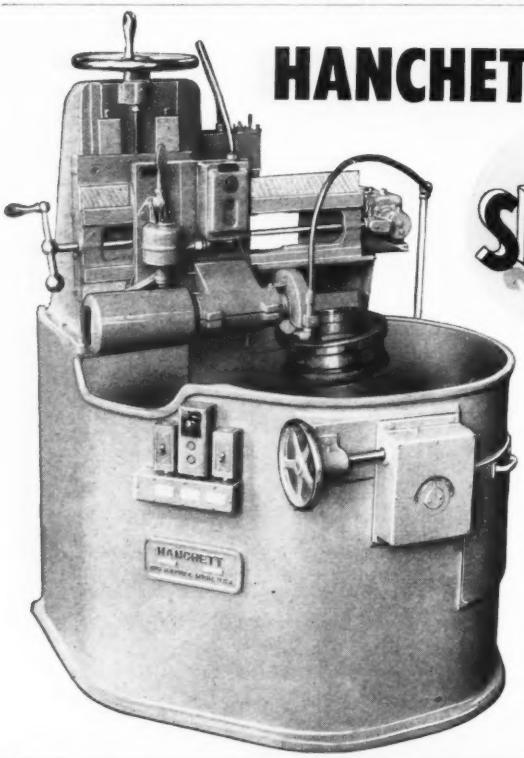
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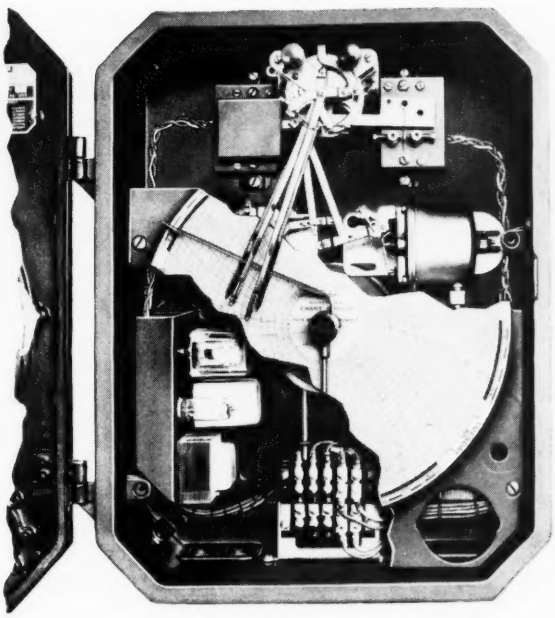
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For full details ask your Taylor Field Engineer or write for **Bulletin 98265.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

FEATURES

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Thiokol Announces New Butyl Rubber Development Program

New team of experienced rubber chemists will work with manufacturers for effective production methods on new BUTYL applications.

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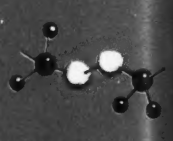
You'll find these Thiokol representatives are well experienced in rubber technology. They have fully staffed and equipped technical and research laboratories at their command. It is their desire to supply you with the latest technical information on BUTYL rubber. Consider them a part of your own staff . . . an able and willing addition to your own technical facilities.

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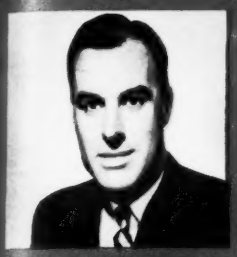
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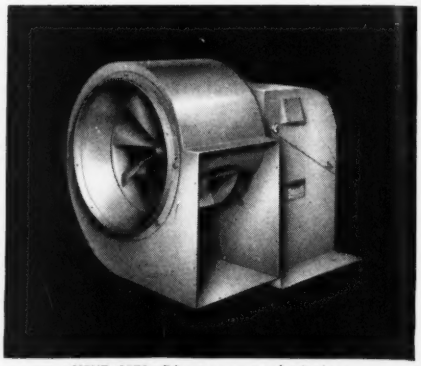
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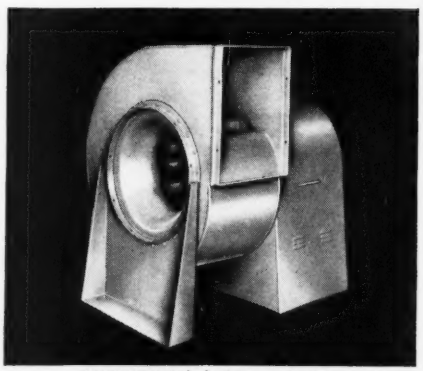
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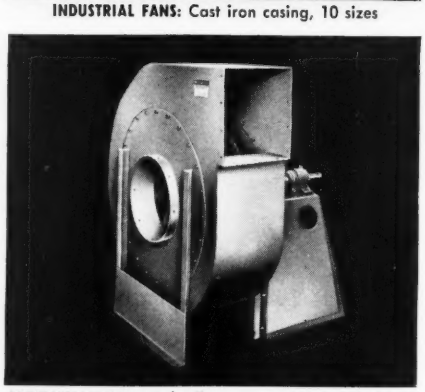
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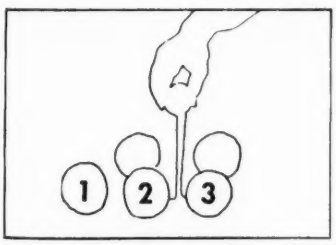


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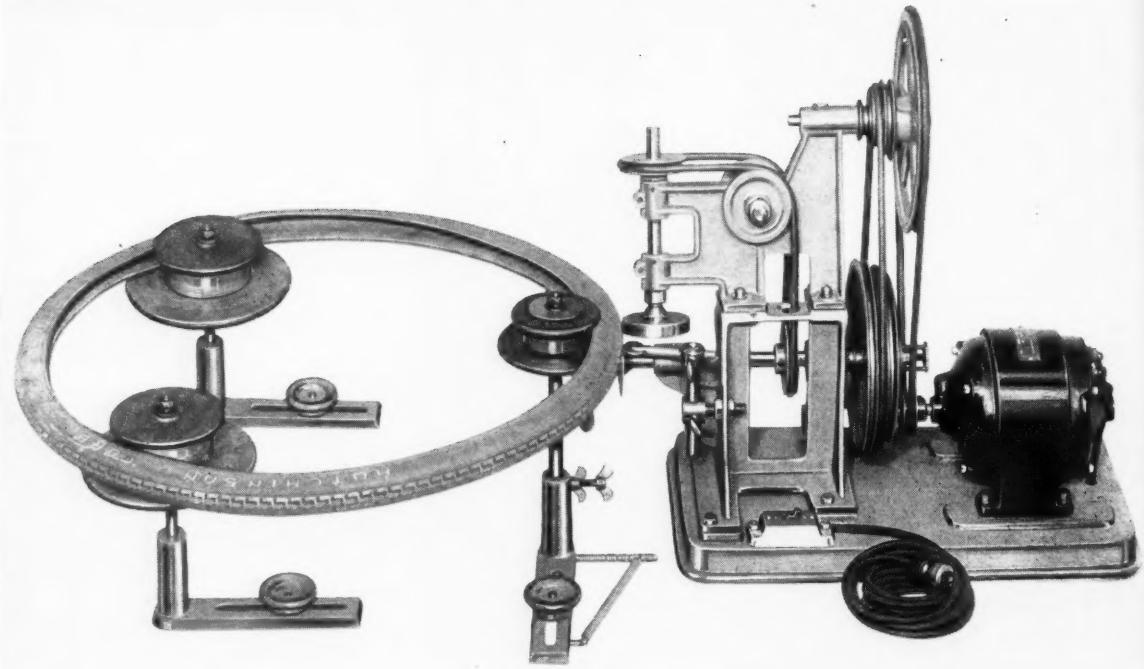
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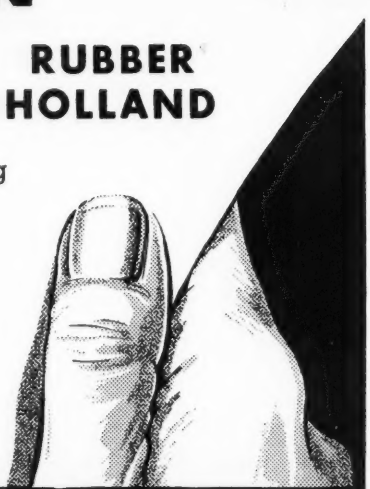
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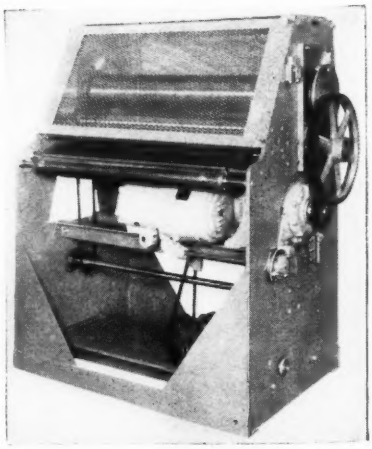
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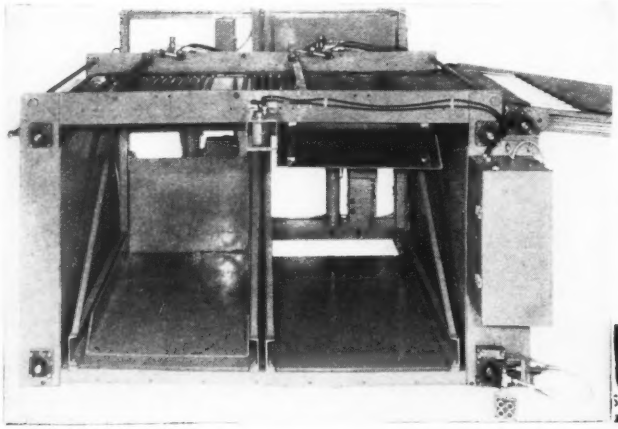
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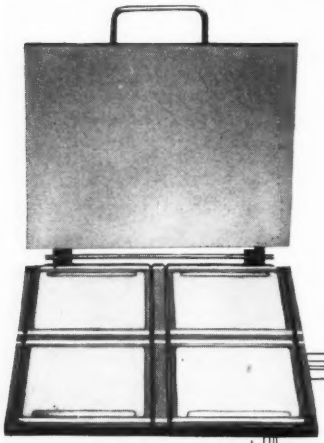
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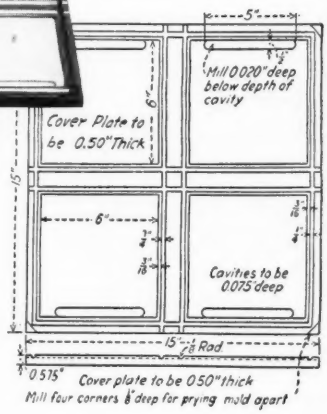
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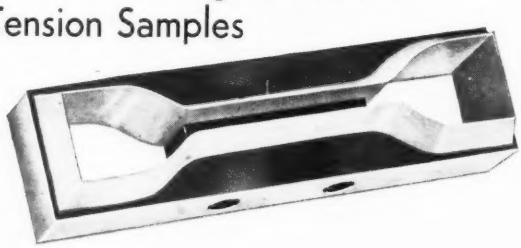


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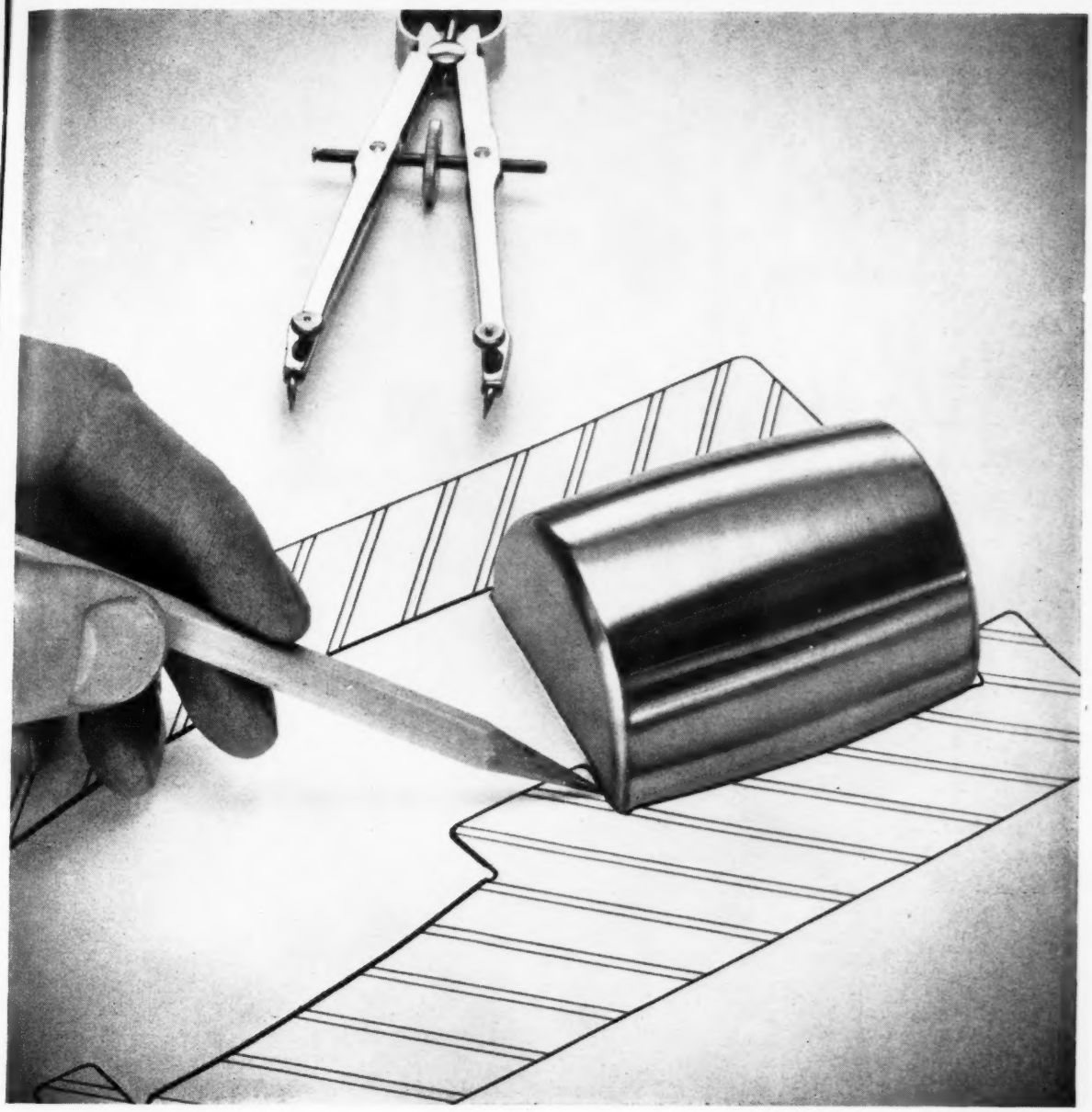
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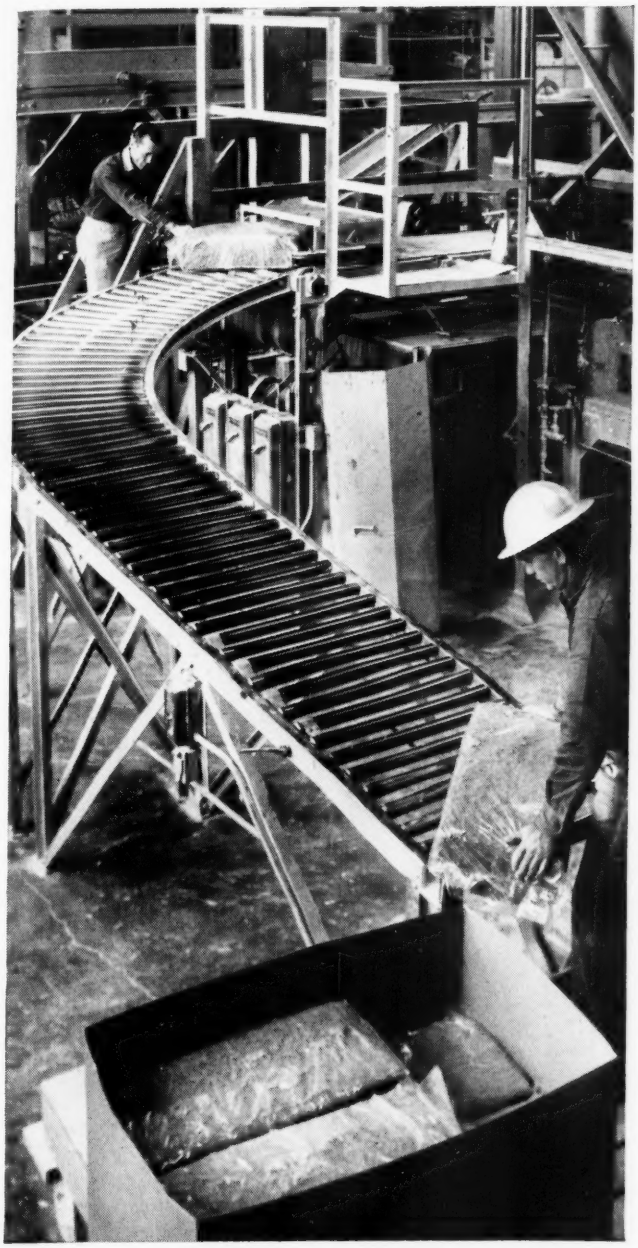
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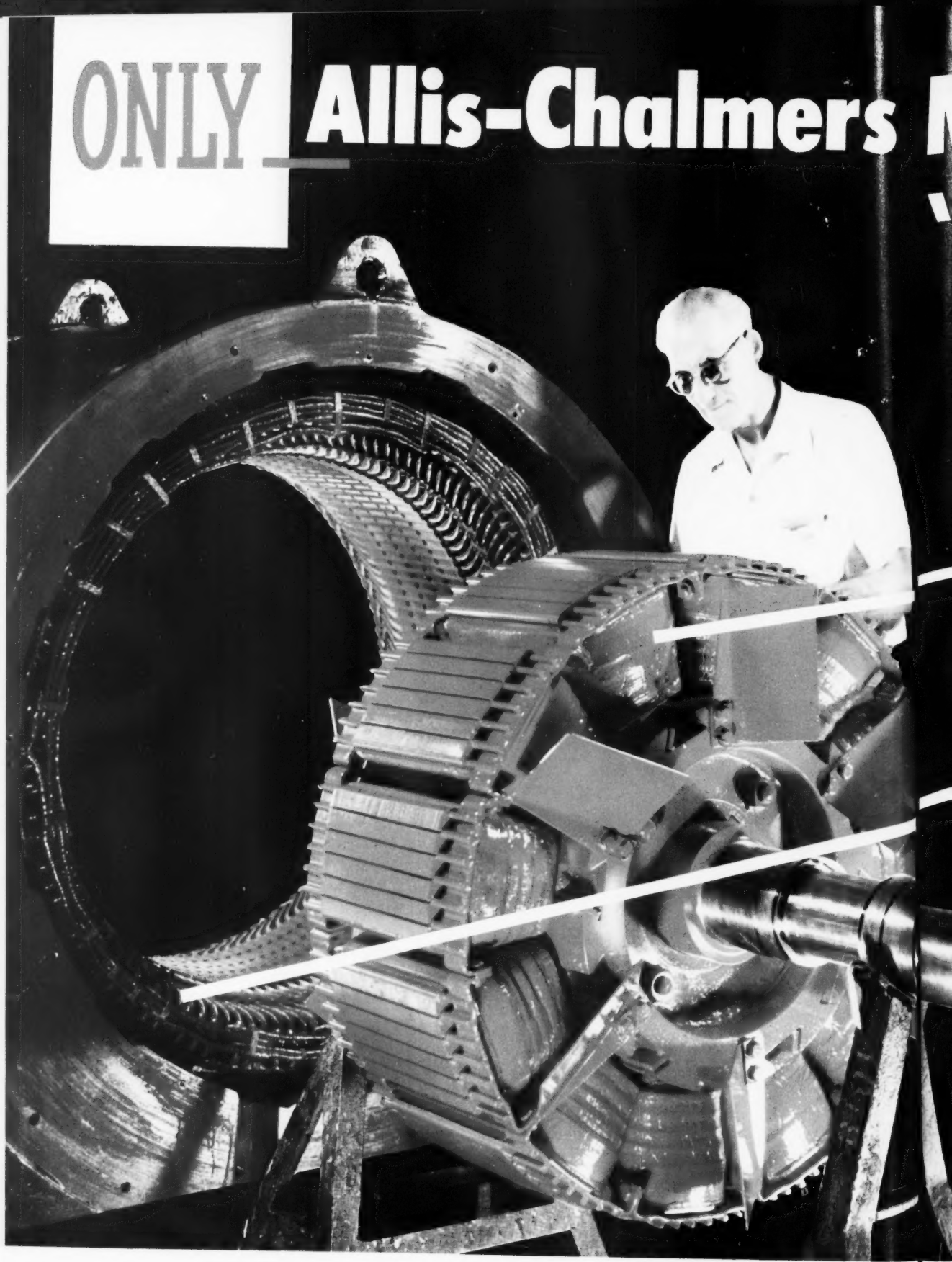
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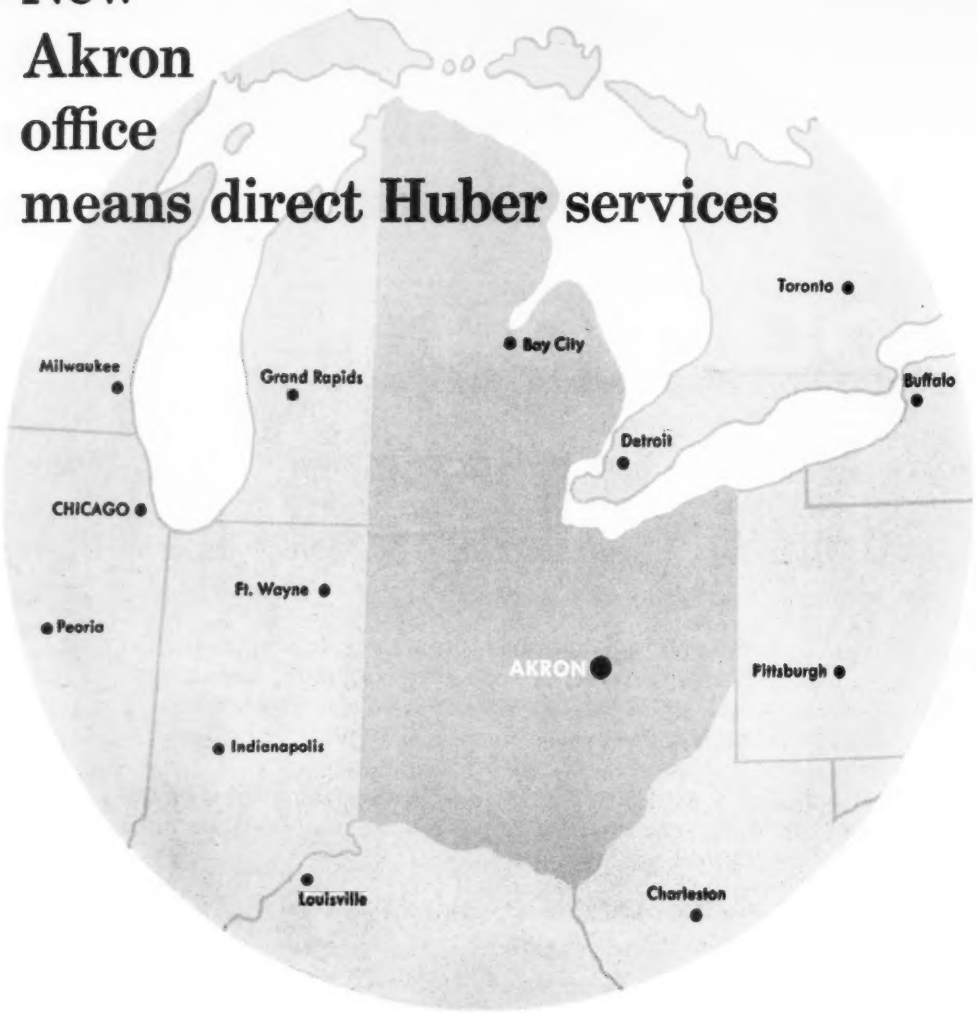
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RUBBER WORLD

EDITORIAL

MARCH, 1957

Natural Rubber Quality; Consumer Gains and Losses

ANOTHER milestone in the long struggle for improved natural rubber quality was passed in February with publication of "Type Descriptions and Packing Specifications for Natural Rubber Grades Used in International Trade," by The Rubber Manufacturers Association, Inc., New York, N. Y. These standards and specifications are endorsed by 24 producing, packing, and consuming organizations in 13 different countries, and *for the first time in the history of this industry, international standards and specifications have been issued.*

The new document supplants the RMA "Type Descriptions and Packing Specifications for Natural Rubber," which with modifications have stood for 28 years as the world's most widely accepted standards for the 30 RMA grades which they covered.

For the past several years consumers of natural rubber in this country and elsewhere have complained continually about the delivery of off-quality, substandard rubber. The RMA and the Rubber Trade Association of New York have been analyzing the quality of natural rubber imported into the United States against the former RMA standards since the end of the Korean War. Actually, this analysis of imports was done first by the U. S. Government when it was the sole purchaser of natural rubber during this Korean War period.

When this study was first made in 1951, it showed that only 58.4% of the imports conformed to RMA standards. Studies for the years, 1952, 1953, and 1954 showed increasing conformance to RMA standards, *but for 1955 conformance was only 62.6%, compared with 71.7% in 1954.*

A review of the import data for the five-year period indicates that the general level of natural rubber quality decreases as the level of natural rubber price increases. The influence of natural rubber quality is not now controlling in the manufacturer's major decision on synthetic or natural rubber use, but it will have an accumulative effect in the years to come unless the natural rubber producing and packing industry takes the steps necessary to improve the quality and uniformity of their product, the RMA pointed out.

In this connection the American Society for Testing Materials' Committee D-11 on Rubber and Rubber-Like Materials has had subcommittee 12 on crude natural rubber working on methods of test for basic technical properties for several years. Many of the technical workers in Malaya and Indonesia as well and in Europe in the rubber research institutes as elsewhere are acquainted with this ASTM work.

If the natural rubber producing and packing industry and consumers of natural rubber desire improved quality, each of the organizations that have cooperated in developing these international visual standards should urge first that all their members make full use of them. In addition, all of these organizations should cooperate more fully in the ASTM work on methods of test for the basic technical properties of natural rubber.

The next meeting of the ASTM subcommittee on crude natural rubber will be held in June of this year, and representation at that meeting from both producing and consuming organizations abroad would do much to continue the progress in improving natural rubber quality on a world-wide basis.

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Curing Systems for Improved Aging Resistance of Rubber Vulcanizates—I[1]

By Z. T. OSSEFORT, R. F. SHAW, E. W. BERGSTROM
U. S. Army, Ordnance Corps, Rock Island Arsenal, Rock Island, Ill.

The Army Ordnance aging program on rubber has revealed that the most severe aging factors are ozone, heat, and oxygen. This paper is concerned with those factors *except* ozone which are responsible for the deterioration of rubber goods in storage.

Long-term atmospheric and shelf aging and the accelerated aging of unstressed rubber vulcanizates have indicated that proper choice of curing system is the most important means of obtaining rubber items having superior resistance to aging.

Sulfur-accelerator cured vulcanizates are especially susceptible to aging by oxygen and to after-vulcanization which latter occurs in the complete absence of gaseous oxygen. Vulcanizates cured with sulfur-bearing accelerators only, and with dicumyl peroxide, on the other hand, have excellent resistance to aging whether oxygen is present or not.

THE useful service and storage life of rubber articles is affected by a variety of factors among which are heat, oxygen, ozone, light, and internal reactions leading to degradation such as continued vulcanization and polymerization. The Army Ordnance Corps, as the largest military user of rubber items, has supported an extensive research and development program directed toward investigating these factors with the ultimate objective of writing realistic specifications which will insure the procurement of rubber goods having improved aging resistance.

Army Ordnance Aging Programs

The interest of Army Ordnance and other Department of Defense agencies, with reference to rubber aging, is considerably different from that of most commercial users of rubber items. This interest embraces two primary considerations: (1) availability in storage of essential rubber items (in usable condition) for emergency use without recourse to the time-consuming processes of manufacture and procurement, and (2) avoidance of continual replacement (at great expense to the tax payer) of essential rubber products due to their deterioration while in storage. During these times of uncertain global conditions, such considerations assume even greater importance.

The principal objectives of the Army Ordnance aging program on rubber have been to determine: (1) the basic factors involved in aging and relative importance of each, (2) which accelerated aging method gives the best correlation with "natural" aging, (3) which physical and/or chemical property gives the best indication of aging resistance, (4) what can be done to improve the aging resistance of rubber, and (5) how to develop specifications which insure procurement of rubber end-items having adequate aging resistance for military applications.

This program has revealed that the most severe aging factors are ozone, heat, and oxygen. Attack by ozone is rapid, dramatic, readily apparent to the eye and leads in many cases to immediate failure of the article. Most of the other aging processes are less obvious and generally do not cause rapid destruction of the end-item. These latter processes manifest themselves primarily in physical property changes in the rubber, i.e., lowered elongation and tensile strength and an ever-increasing modulus and hardness which may eventually lead to complete embrittlement.

In the vast majority of cases, however, it is practically impossible to relate the effects of such aging directly to end-item failure. A lowered performance efficiency and shorter service life can only be inferred from a measured reduction in physical properties of the rubber product.

It is fortunate, at least from an investigational standpoint, that ozone deterioration can be separated from the other aging factors by the simple expedient of

[1]The opinions or assertions contained herein are not to be construed as official or reflecting the views of the Department of the Army.

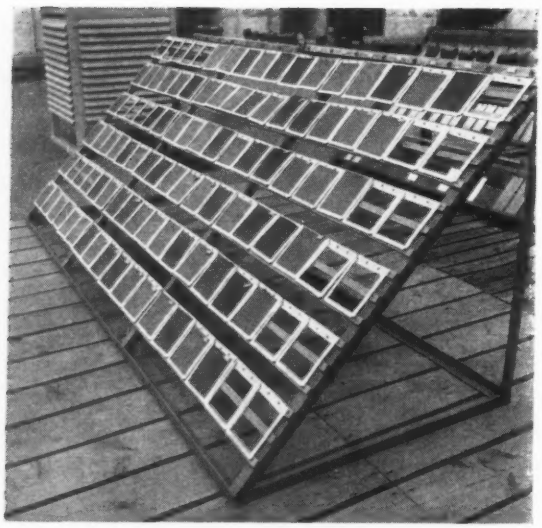


Fig. 1. Outdoor exposure rack for aging natural rubber compounds

removing stresses from the rubber samples during aging. Also, ozone deterioration is generally present only during atmospheric exposure while the other aging factors are present regardless of the storage environment. A great deal of information has been published on the effects of ozone cracking and means for its prevention.[2-5] The present writing will be restricted to those factors *except* ozone which are responsible for the deterioration of rubber goods during long-term storage.

Chemical Changes during Aging

The chemical changes produced during aging of vulcanizates based on the diene rubbers are of three principal types:

1. The long polymeric chains may be joined together or "cross-linked" by various agents such as oxygen, sulfur, and alkyl bridges.

2. The polymeric molecules may be ruptured and broken into two or more smaller fragments by reaction with ozone or oxygen. This is the so-called "chain-scission" reaction.

3. The chemical nature of the side groups along the chains may be altered by oxidation.

Accompanying Physical Changes

The chemical changes produced by each of these reactions are associated with specific changes in the physical properties of the vulcanizate. Thus the cross-linkage reaction is generally accompanied by a lowered elongation with increased hardness, stiffness (modulus), and tensile strength. The chain scission, on the other hand, causes a softening of the rubber and lowering of tensile strength with increased elongation. The modification of side groups causes changes in properties which vary with the nature of the changes in these groups. Stress-strain properties are usually not affected markedly, but "chemical" properties such as solvent resistance are affected

Since all three chemical changes must be presumed to be occurring simultaneously during aging, the resulting physical properties will depend upon which of the reactions predominates. Consequently, if one wishes to deduce which aging reaction is predominant in a given aging process, he may examine the physical properties after the aging process and reason back as to which reaction caused most of the aging.

Numerous long-term "natural" and accelerated aging results (air oven at 158 and 212° F.) have been analyzed in this manner, and it was found that, in general, for compounds protected by antioxidants, hardness, modulus, and tensile strength increased (except for natural rubber in which tensile decreases) while elongation was lowered. These are exactly the changes associated with the cross-linkage reaction (1 above) and tend to indicate that this is the predominating aging process.

Curing Systems Examined

The use of non-free sulfur curing systems to produce excellent resistance to the above-described effects of aging has long been known. Such cures have been and are being investigated by this laboratory since they appear to provide one of the best means for obtaining rubber compounds having superior resistance to aging. The present work was performed with the objective of reemphasizing the importance of properly choosing the curing system in order to obtain rubber vulcanizates with good resistance to aging. To this end, aging studies, both accelerated and long-term "natural," were made using the following four curing systems:

1. Sulfur plus sulfur-bearing accelerators.
2. Sulfur-bearing accelerators only.
3. Dicumyl peroxide.
4. High-energy (gamma) radiation.

A comparison of the aging of vulcanizates prepared using these systems both with and without antioxidant will be presented in an effort to demostrate the following principal points:

1. When the proper choice of curing system is made, atmospheric oxygen is relatively unimportant in aging of rubber.

2. Rubber compounds cured by sulfur plus sulfur-bearing accelerators are especially sensitive to aging by oxygen.

3. Choice of proper curing system is more important for obtaining age resistance in rubber vulcanizates than use of antioxidant.

4. Antioxidants are important in providing age resistance to rubber compounds cured with peroxide, radiation, or free sulfur plus accelerators, but certain accelerator cures age well even in the complete absence of antioxidant.

5. The transference of compounding ingredients between rubber compounds aged in an air oven is only of importance with particularly "age sensitive" compounds.

6. Change of elongation represents the most reliable

[2] J. M. Buist, G. N. Welding, *Trans. Inst. Rubber Ind.*, 21, 49 (1945).
[3] J. Crabtree, A. R. Kemp, *Ind. Eng. Chem.*, 38, 278 (1946).
[4] H. A. Winkelmann, *Ibid.*, 44, 841 (1952).
[5] R. F. Shaw, Z. T. Ossefort, W. J. Touhey, RUBBER WORLD, 130, 5, 636 (1954).



Z. T. Ossefort



R. F. Shaw



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He is a member of the American Chemical Society and its Rubber Division.

criterion for following and assessing the aging of diene rubbers.

Procedure and Results

In the work which will subsequently be described, a wide variety of rubber formulations was used. For ready reference these have all been grouped together and are presented in Table 1.

All compounds in Table 1 were mixed, cured, and tested in accordance with ASTM[6] procedures where applicable. For the accelerated tests, the original physical properties were determined 24 hours before the samples were placed in the aging tests, and the aged physical properties were determined 16 to 72 hours after the samples had been removed from the aging media. Three specimens were used for each determination of the elongation at 400 psi. (NBS strain tester)[7] and five specimens for the other tests. Departures from ASTM procedures or special tests used will be described in greater detail at the appropriate point in the text.

Long-Term Atmospheric and Shelf Aging

Table 2 indicates the order of magnitude of the deterioration experienced during storage (natural aging) of truck tires in atmospheric exposure. The tires were unused and varied in age as shown.

DUMBBELL TIRE TREADS. Specimens were taken from the tire treads and tested in comparison with the original values of the tread stock as obtained from the tire manufacturer. Theses results indicate that elongation drops very severely during long-term storage, but tensile and hardness are only little affected. (Some of the results obtained in later work actually yielded increase tensile values over the original.)

An interesting observation made during these studies was that the depth at which the specimen was taken from the tire tread section had no appreciable effect on the degree of aging. Results in Table 3 illustrate this point.

[6] American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

[7] India RUBBER WORLD, June, 1948, p. 367; July, 1948, p. 513.

TABLE 1. FORMULATIONS OF RUBBER COMPOUNDS

Parts by Weight

Compounding Ingredient	A1	644/37	S1	430	644/43	N3	441	S77 DA	S77 D	S77 DAC	S77 CD	S77	S77 DC1	A11 A1	A11 A1C	A11 A1C1	N87	N87 C	N87 C1
Smoked sheets		100																	
Pale Crepe	100													100	100	100			
GR-S 1500 (uninhibited)								100	100	100	100		100						
GR-S AC (SBR 1004)[a]					100	100													
GR-S X454 (SBR 1505)				100															
GR-S 1600												150							
GR-S (76.5/23.5 Bd./sty. @ 122° F.—SBR 1000)			100																
GR-S 1104																			
Nitrile rubber[b]						100	100										100	100	100
Zinc oxide	5	3	5	3	2.4	5	5	3	3	3	3	3	3	3	3	3	5	5	5
Stearic acid	1	3	2	2	2.4	1	1	2	2	2	2	2	2	2	2	2	1	1	1
Petroleum waxes[c]																			
Polymerized trimethyl-dihydroquinoline[d]				1		1	1										1	1	1
PBNA, phenyl beta naphthylamine[e]	1			1					1		1	1	1	1	1	1			
Antioxidant (undisclosed type)		1.5																	
Sulfur		3		1.75	2		1	1.75	1.75			1.75		1.75			1.5		
2-Mercaptobenzothiazole[f]			1.5							1	1				1			1	
Dipentamethylene thiuram tetrasulfide[g]										1	1				1			1	
Benzothiazyl disulfide[h]				1		1	1.5										1.5		
N-cyclohexyl-2-benzothiazole sulfenamide[i]								1	1			1		1					
Tetramethyl thiuram disulfide[j]	3																		
Tellurium[k]	0.5																		
Tetraethyl thiuram disulfide[l]			2.5			3.5													
Dicumyl peroxide[m]													5			5			2.5
Accelerator (undisclosed type)		1			1.2														
HAF carbon black								50	50	50	50		50						
EPC carbon black		50			50														
CF carbon black																			
MT carbon black	25					75													
FT carbon black	25						50												
MPC carbon black			50																
MAF carbon black				50			50							50	50	50	50	50	50
Coal-tar distillate			5																
Glycol ester of vegetable oil fatty acid[n]						10													
Process oil	1	4			4														
Dibutyl sebacate						10													
Amorphous resin						10													
High molecular weight polyester[o]				5			10												
Polyethylene glycol di-2-ethyl hexoate[p]							5												

NOTE: All test pads were cured 30 min. @ 307° F. except Compounds S81 DR and S81DAR which were cured by exposure to 33 megareps of gamma radiation. Compounds 64437 and 64443 were prepared by Firestone Laboratories and were cured 40 minutes @ 280° F. and 60 minutes @ 280° F., respectively.

[a]SBR is the ASTM Designation 1418-56T for styrene-butadiene rubber and now replaces "GR-S" or "Government Rubber-Styrene." SBR code numbers in parentheses are the present-day designation for these former GR-S code numbers.

[b]Paracril 18-80, Naugatuck Chemical Division, United States Rubber Co., trade mark.
[c]Heliozone, E. I. du Pont de Nemours Co., Inc. trade mark.
[d]AgeRite Resin D, R. T. Vanderbilt Co. trade mark.
[e]Neozone D, Du Pont trade mark.
[f]Captax, Vanderbilt trade mark.
[g]Tetrone A, Du Pont trade mark.
[h]Altax, Vanderbilt trade mark.
[i]Santocure, Monsanto Chemical Co. trade mark.
[j]Methyl Tuads, Vanderbilt trade mark.
[k]Telloy, Vanderbilt trade mark.

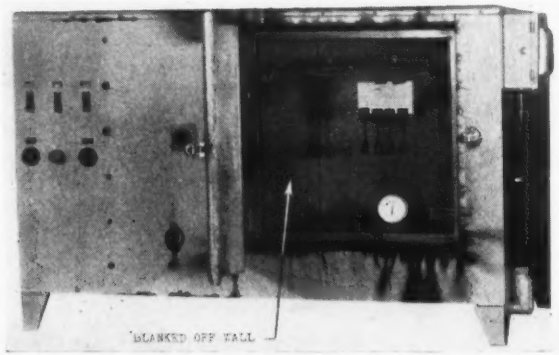
[l]Ethyl Tuads, Vanderbilt trade mark.
[m]DiCup 40C, Hercules Powder Co. trade mark.
[n]Plasticizer SC, Harwick Standard Chemical Co. trade mark.
[o]TP 90B, Thiokol Chemical Corp. trade mark.
[p]Flexol 4GO, Carbide & Carbon Co. trade mark.
[q]AgeRite HiPar, Vanderbilt trade mark.
[r]AgeRite Powder, Vanderbilt trade mark.
[s]Octamine, Naugatuck Chemical Co., U. S. Rubber, trade mark.
[t]UOP 88, Universal Oil Products Co. trade mark.
[u]Plastogon, Vanderbilt trade mark.

TABLE 1 (*Continued*)

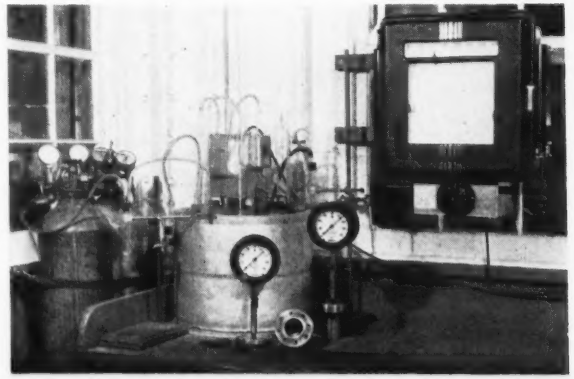
TABLE 1 (*Continued*)

Compounding Ingredient	S52 C109 DA	S47 A3B 13	S52 C109 DAB	S52 C110 DAB	N94 C1E	N94 C1BE	S12	S27	S45 DA	A6E	A8	S12 A18	S12 A19	S12 A20	S12 A22	S52	S52 A	S52 C	S52 AC	S52 C14	S52C 14A	S81 DR	S81 DAR
Smoked sheets										100	100												
Pale crepe																							
GR-S 100 (SBR 1500)		100							100														
GR-S X600 (SBR 1505)							100					100	100	100	100								
GR-S X628 (SBR 1700)								125															
GR-S 1500																							
GR-S 1500 (uninhibited)																							
GR-S 1104	150		150	150												100	100	100	100	100	100	100	100
Nitrile rubber[b]					100	100																	
Zinc oxide		3			5	5	3	3	3	5	5	3	3	3	3	3	3	3	3				
Stearic acid		2			2	2	2	2	1	1	1	2	2	2	2	1	1	1	1				
Petroleum waxes[e]		1																					
Polymerized trimethyl-dihydro-quinoline		1			1	1	1	1						1									
Phenyl beta naphthylamine		1					1	1	1				1			2		2			1.25		1.25
PBNA, isopropoxy diphenylamine diphenyl paraphenylemadiamine[q]											1												
Phenyl beta naphthylamine[r]									1	1													
Diphenylamine-diisobutylene[s]															1								
N, N′ dioctyl-p-phenylene-diamine[t]		3	3	3		3																	
Sulfur		1.75					1.75	1.75		1.75	.5	1.75	1.75	1.75	1.75	1.75	1.75						
2-Mercaptobenzothiazole									1									1	1				
Dipentamethylene thiuram tetra-sulfide								1										1	1				
N-cyclohexyl-2-benzothiazole sulfenamide		1					1	1		1		1	1	1	1	1	1						
Tetramethyl thiuram disulfide											3												
Dicumyl peroxide	2.5		2.5	5	3.75	3.75														2.5	2.5		
Accelerator (undisclosed type)																							
CF carbon black										50													
MAF carbon black		50			50	50	50	50	50		50	50	50	50	50	50	50	50	50	50	50	50	50
Polyethylene glycol di-2-ethyl hexoate					15	15																	
Oil soluble sulfonic acid and paraffin oil[u]											1												

NOTE: Footnotes appear on facing page.



(Left) Fig. 2. Modified mechanical convection air oven



(Right) Fig. 3. Apparatus for test tube aging, *left;* oxygen bomb aging, *center;* and potentiometer recorder, *right*

TABLE 2. AVERAGE CHANGE IN PHYSICAL PROPERTIES OF TIRES WITH NATURAL AGING

Age of Tire, Years	No. of Tires Tested	Tensile, % of Orig. Value	Elongation, % of Orig. Value	Avg. Hardness (Shore A) Increase
5	27	83	55	8
6	9	80	65	6
7	3	71	39	10
8	4	75	48	9

rubber compounds based on two different curing systems.

The very excellent age resistance of the accelerator-cured (A1 compound) rubber during both outdoor and shelf aging is much in evidence and in sharp contrast with the poor aging of the sulfur-cured compound. It is evident that after only three years outdoors the sulfur cured rubber had deteriorated to the point of failure for most applications; while the non-free sulfur-cured rubber is still useful after five years outdoors and essentially unchanged after seven years' shelf aging.

TABLE 3. PHYSICAL PROPERTIES TAKEN AT VARIOUS DEPTHS FROM THE TIRE TREAD SURFACE INWARD

Tire Serial No.	Physical Property	Properties Listed in Order of Layers from Tread Inward: 1st	2nd	3rd	4th	5th	6th	7th	Orig. Unaged Composition
488M7910	Tensile, psi.	1570	1200	1050	1150	1550	1310	1250	1635
	Elong., %	430	350	340	340	420	400	350	500
14382A2	Tensile, psi.	1500	1800	1850	1720	1480	1470	1080	2700
	Elong., %	390	450	440	430	400	410	330	790
8G124815	Tensile, psi.	1270	1270	1470	1270	1240	1610	1610	*
	Elong., %	460	500	540	500	440	580	540	
A79T0401	Tensile, psi.	1520	1560	1740	1430	1540	—	—	1635
	Elong., %	390	360	390	340	340	—	—	500
G34L9640	Tensile, psi.	1470	1475	1450	1525	1740	—	—	1635
	Elong., %	390	370	350	350	350	—	—	500
W635981	Tensile, psi.	1590	1600	1160	980	—	—	—	*
	Elong., %	300	300	250	210	—	—	—	
055503229	Tensile, psi.	1180	1600	1490	1420	—	—	—	2250
	Elong., %	340	410	400	350	—	—	—	485

NOTE: Tires were five to six years old at time of test.
*No original sample.

TABLE 4.
OUTDOOR AND SHELF AGING OF SULFUR *VS.* NON-FREE SULFUR CURED NATURAL RUBBER

Compound and Curing System	Aging Time and Condition	Tensile, Psi.	Elongation, %	Hardness, Shore A
A1—	original	2675	650	46
Accelerators only	1 yr.—outdoors	2500	600	48
	3 yrs.—outdoors	2150	560	46
	5 yrs.—outdoors	1640	600	50
64437—	original	3730	490	75
Sulfur + accelerator	1 yr.—outdoors	2800	390	79
	2 yrs.—outdoors	2300	330	80
	3 yrs.—outdoors	980	150	80
	4 yrs.—outdoors	735	130	78
A1—	original	2675	650	46
Accelerators only	1 yr.—shelf	2895	625	50
	3 yrs.—shelf	2650	640	48
	5 yrs.—shelf	2910	585	52
	7 yrs.—shelf	2790	630	55

Owing to the difficulty in preparing specimens, a considerable dispersion of results was obtained, but it is evident that deterioration was quite uniform throughout the tire cross-section.

Since little was known about the composition of these tires, conclusions regarding the relation of aging to curing system could not be made. The information which was obtained and knowledge as to common practice in tire manufacture as well as the aging characteristics of these vulcanizates indicate that these tires were based on a sulfur plus sulfur-bearing accelerator curing system.

NR SLABS. To obtain the information necessary to relate "natural aging to the type of curing system used in preparing the rubber, results of long-term atmospheric (Figure 1) and shelf exposure (unstressed) of rubber specimens must be examined. In Table 4 are presented data for outdoor and shelf aging of natural

TABLE 5. OUTDOOR AGING OF SULFUR *VS.* NON-FREE SULFUR-CURED SBR

Compound and Curing System	Aging Time	Tensile, Psi.	Elongation, %	Hardness, Shore A	Strain, % E. @ 200 Psi.
S1—	original	1650	690	58	—
Accelerators only	1 yr.	1650	550	70	—
	3 yrs.	1640	540	68	—
	4 yrs.	(2045)	520	72	—
	5 yrs.	1970	510	73	—
430—	original	2040	480	57	105
Sulfur + accelerator	1 yr.	2435	370	65	51
	2 yrs.	2170	340	72	47
	3 yrs.	1820	290	72	42
	4 yrs.	2065	240	72	30
64443—	original	2315	485	69	63
Sulfur + accelerator	1 yr.	1850	350	76	41
	2 yrs.	1980	360	77	45
	3 yrs.	1880	230	81	30
	4 yrs.	1660	220	78	30

TABLE 6. SHELF AGING OF SULFUR *VS.* NON-FREE SULFUR-CURED SBR

Compound and Curing System	Aging Time	Tensile, Psi.	Elongation, %	Hardness, Shore A	Strain, % E. @ 200 Psi.
S1—	original	1650	690	58	—
Accelerators only	1 yr.	1750	675	60	—
	3 yrs.	1800	670	62	—
	5 yrs.	1855	660	65	—
	7 yrs.	1770	600	67	—
430—	original	1930	420	56	149
Sulfur + accelerator	1 yr.	2385	390	65	59
	2 yrs.	2495	370	71	51
	3 yrs.	2170	330	62	43
	4 yrs.	2330	320	66	45
	5 yrs.	2265	310	66	43

In Table 5 the outdoor aging of sulfur and non-free sulfur-cured styrene-butadiene rubber (SBR)[8] compounds is compared. At this point it should be stated that the degradation of tensile strength is not a prime factor in the aging of SBR as it is in natural rubber. In fact, in SBR the tensile strength usually increases during the early stages of accelerated aging, and as these results indicate, tensile strength also tends to increase during long-term natural aging.

The principal changes in physical properties resulting from the aging of SBR are increased modulus and hardness and decreased elongation. With these facts in mind, it is evident that the accelerator-cured SBR compounds aged less than the sulfur cured. The rapid rise of modulus in the sulfur-cured rubbers is shown by the sharp drop in NBS strain values. Unfortunately, NBS results are not available for the non-free sulfur-cured SBR.

Results of shelf aging of similar compounds shown in Table 6 bring out the same conclusions. These data show that the sulfur-cured compound has aged more after five years' shelf storage than the accelerator-cured rubber has after seven years.

Some results on the outdoor and shelf aging of sulfur and non-free sulfur-cured nitrile rubbers are given in Tables 7 and 8 respectively. The same general trends are noted with the nitrile rubbers as were observed with SBR.

TABLE 7. OUTDOOR AGING OF SULFUR *vs.* NON-FREE SULFUR-CURED NITRILE RUBBER

Compound and Curing System	Aging Time	Tensile, Psi.	Elongation, %	Hardness, Shore A	Strain, % E. @ 200 Psi.
N3—	original	850	1120	40	—
Accelerators only	1 yr.	750	850	50	—
	3 yrs.	745	—	48	—
	4 yrs.	805	840	50	—
	5 yrs.	890	785	51	—
441—	original	1520	360	63	83
Sulfur + accelerators	1 yr.	1550	300	73	46
	2 yrs.	1540	280	82	37
	3 yrs.	1450	220	79	29
	4 yrs.	1650	210	83	25
	5 yrs.	1385	190	84	22

TABLE 8. SHELF AGING OF SULFUR *vs.* NON-FREE SULFUR-CURED NITRILE RUBBER

Compound and Curing System	Aging Time	Tensile, Psi.	Elongation, %	Hardness, Shore A	Strain, % E. @ 200 Psi.
N3—	original	850	1120	40	—
Accelerators only	1 yr.	985	1100	42	—
	3 yrs.	870	1150	38	—
	4 yrs.	835	1115	40	—
	7 yrs.	965	1020	47	—
441—	original	1370	340	64	74
Sulfur + accelerator	1 yr.	1410	335	70	58
	2 yrs.	1530	320	73	62
	3 yrs.	1460	—	71	50
	4 yrs.	1645	290	71	49
	5 yrs.	1745	270	71	45

None of the compounds discussed thus far was cured with a high level of sulfur with the exception of the natural rubber compound which had three phr. These compounds were not set up with the deliberate intent of showing the superior aging of non-free sulfur over sulfur cures. If this were the case, a higher level of sulfur would have been used in the sulfur-cured compounds.

The results thus far presented lead to the conclusion that the aging of diene rubbers during outdoor and shelf aging (unstressed) can be considerably reduced by the proper choice of curing system. It is also indicated that vulcanizates prepared using free sulfur as part of the curing system have a particular sensitivity to the factors producing aging of the rubbers.

Accelerated Aging Studies

In order to determine whether the use of increased quantities of antioxidants would improve the age resistance of sulfur-accelerator cured SBR, a series of compounds using various quantities and types of antioxidants was investigated. Results of these tests are provided in Table 9. As may be seen, neither the amount nor type of antioxidant added to these compounds affected their resistance to air oven aging.

TABLE 9. EFFECT OF ADDED ANTIOXIDANT ON AIR OVEN (ASTM D 573-52) AGING OF SBR

		S12	S12 A18	S12 A19	S12 A20	S12 A22
Parts of Antioxidant Added per 100 R. H. C.	Neozone D	1	0	1		
	AgeRite Resin D	1	0		1	
	Octamine		0			1
Nature of Test Conditions						
Tensile, psi.	original	2670	2740	2810	2740	2720
	7 dys. @ 158° F.	2660	2850	2800	2740	2730
	70 hrs. @ 212° F.	2500	2640	2680	2600	2500
Modulus, psi. @ 300% E.	original	1490	1410	1390	1450	1380
	7 dys. @ 158° F.	2290	2270	2040	2000	1960
	70 hrs. @ 212° F.	none	none	none	none	none
Ultimate elongation, %	original	470	480	500	470	500
	7 dys. @ 158° F.	360	360	360	340	—
	70 hrs. @ 212° F.	300	290	300	270	280
Elongation @ 400 psi., NBS	original	139	137	140	139	141
	7 dys. @ 158° F.	102	102	104	104	103
	70 hrs. @ 212° F.	88	85	86	88	89
Hardness, Shore A	original	64	64	64	64	64
	7 dys. @ 158° F.	67	69	68	68	68
	70 hrs. @ 212° F.	72	71	70	71	72
% Weight change	7 dys. @ 158° F.	−0.4	−0.6	−0.7	−0.6	—
	70 hrs. @ 212° F.	−1.7	−1.4	−1.8	−1.6	—

The compound (S12A18), having no added antioxidant, resisted the effects of oven aging as well as those compounds having one or two parts antioxidant added. These compounds were all prepared using an ordinary SBR polymer which contained the usual 1.25 parts antioxidant. It appears, therefore, that a "leveling" effect

[8] ASTM Designation D 1418-56 T for styrene-butadiene rubber now replaces GR-S or "Government Rubber Styrene."

TABLE 10. EFFECT OF ANTIOXIDANT AND CURING SYSTEM ON THE RESISTANCE OF SBR* TO OVEN AGING FOR 70 HOURS AT 212° F.

RIA Cpd. No.	Type Curative	Anti-oxidant (PBNA)	Type Oven	Sample Combination	Tensile, Psi.		300 % Mod.		% Elong.		Shore A		% E. @ 400 Psi. (NBS)	
					Orig.	Aged	Orig.	Aged	Orig.	Aged	Orig.	Aged	Orig.	Aged
S52A	Sulfur-accelerator	0	modified†	alone	2420	1350	1380	—	480	170	67	70	147	71
S52	Sulfur-accelerator	2	modified†	alone	2430	2650	1260	2580	530	310	65	71	148	84
S52AC	Accelerators only	0	modified†	alone	2260	2390	830	1340	570	460	63	66	181	150
S52C	Accelerators only	2	modified†	alone	2250	2400	900	1250	620	510	63	65	179	143
S52A	Sulfur-accelerator	0	modified†	all 4 spds. together	2420	2200	1380	—	480	250	67	75	147	81
S52	Sulfur-accelerator	2	modified†	all 4 cpds. together	2430	2510	1260	—	530	320	65	75	148	87
S52AC	Accelerators only	0	modified†	all 4 cpds. together	2260	2480	830	1240	570	490	63	69	181	150
S52C	Accelerators only	2	modified†	all 4 cpds. together	2250	2400	900	1290	620	510	63	70	179	152
S52C	Acceleratots only	2	modified†	with S52	2250	2420	900	1370	620	490	63	65	179	138
S52	Sulfur-accelerator	2	modified†	with S52C	2430	2590	1260	2490	530	320	65	74	148	83
S52A	Sulfur-accelerator	0	modified†	with S52AC	2420	1500	1380	—	480	180	67	75	147	71
S52AC	Accelerators only	0	modified†	with S52A	2260	2490	830	1340	570	480	63	67	181	142
S52A	Sulfur-accelerator	0	conventional‡	alone	2420	1420	1380	—	480	230	67	75	147	68
S52	Sulfur-accelerator	2	conventional‡	alone	2430	2540	1260	2350	530	330	65	83	148	73
S52AC	Accelerators only	0	conventional‡	alone	2260	2510	830	810	570	540	63	67	181	139
S52C	Accelerators only	2	conventional‡	alone	2250	2520	900	1230	620	500	63	66	179	136
S52A	Sulfur-accelerator	0	conventional‡	all 4 together	2420	2380	1380	—	480	290	67	75	147	79
S52	Sulfur-accelerator	2	conventional‡	all 4 together	2430	2530	1260	2350	530	330	65	75	148	80
S52AC	Accelerators only	0	conventional‡	all 4 together	2260	2520	830	1210	570	520	63	70	181	135
S52C	Accelerators only	2	conventional‡	all 4 together	2250	2370	900	1160	620	500	63	69	179	137
S52AC	Accelerators only	0	conventional‡	with S52A	2260	2480	830	1240	570	490	63	66	181	143
S52A	Sulfur-accelerator	0	conventional‡	with S52AC	2420	1300	1380	—	480	180	67	74	147	66
S52	Sulfur-accelerator	2	conventional‡	with S52C	2430	2470	1260	2340	530	320	65	73	148	83
S52C	Accelerators only	2	conventional‡	with S52	2250	2430	900	1210	620	500	63	66	179	139
S52	Sulfur-accelerator	2	conventional‡	with S52A	2430	2640	1260	2410	530	330	65	74	148	81
S52A	Sulfur-accelerator	0	conventional‡	with S52	2420	2310	1380	—	480	280	67	74	147	78

*Special polymer containing zero antioxidant.
†ASTM D 573-52 air oven modified to prevent recirculation of air.
‡ASTM D 573-52 oven as received from manufacturer.

is observed here in that the 1.25 parts antioxidant which is normally in the polymer provides as much protection as can be obtained by antioxidants under these conditions.

AIR OVEN MODIFICATION AND TESTS. Air oven aging was used throughout the work reported herein since previous information obtained at this laboratory and in the literature[9] had indicated that air oven aging could be correlated with natural aging better than other accelerated aging tests such as the oxygen and air bombs. The mechanical convection air ovens (ASTM D 573-52) used for aging, however, suffer from many defects, chief among which are the following:

1. Temperature deviations of standard commercial ovens were found to be greater than permitted by ASTM requirements.
2. Rate of air flow is not specified and is difficult to measure and control.
3. Transference or migration of compounding ingredients between different vulcanizates being aged simultaneously may occur.
4. Heated air is recirculated over the specimens.

In order to prevent recirculation of air over the specimens being aged, one of the standard ovens (ASTM D 573-52) used in this work was modified as shown in Figure 2. As may be seen, a solid sheet of aluminum has been substituted for the diffuser wall which was at the left of the aging chamber.

Temperature deviations in the aging chamber for different points at a given time, or for the same point at different times were measured by inserting six iron-constantan thermocouples through the exhaust vent and spotting them at various locations. The maximum deviation at different points throughout the aging chamber was $\pm 2°$ F., and the deviation due to the on-off cycle controlled by the thermostat was $\pm 2.5°$ F. at 212° F.

Since these variations were not within the limits of $\pm 1.8°$ F. as set by ASTM D 573-52, two additional oven modifications were made. In the original oven the sensing element of the thermostat was clamped to the metal wall behind the heater panel. To reduce the heat transfer between the element and this wall and to permit better air flow over this sensing element, two $\frac{3}{16}$-by one- by one-inch pieces of pressed asbestos board were placed between the sensing element and the wall. The last modification consisted of replacing the micro-

[9] R. A. Youmans, G. C. Maassen, *Ind. Eng. Chem.*, 47, 1487 (1955).

switch in the thermostat by a more sensitive microswitch.[10]

After these modifications had been made, the temperature variation at any one location was reduced to $\pm 0.5°$ F. and the temperature variation throughout the chamber was $\pm 1.7°$ F. bringing this oven within the limits allowed by ASTM D 573-52.

Using this modified oven and a conventional oven, accelerated aging tests were conducted on a group of SBR compounds based on two curing systems, *viz.*, sulfur-accelerator and accelerators only. The age resistance of these compounds was tested both with and with out antioxidant. A special SBR polymer[11] to which no antioxidant had been added at time of manufacture was used.

TABLE 11. TRANSFERENCE EFFECTS PRODUCED DURING OVEN AGING OF S52A COMPOUND—70 HOURS @ 212° F.

Nature of Test	Type Oven	Aged Alone or With Compounds Not Containing Antioxidant		Aged in Presence of Other Compounds Containing Antioxidant	
Tensile, psi.	—	original	2420	original	2420
	modified	aged (alone)	1350	aged (w/S52, S52C, and S52AC)	2200
	modified	aged (w/S52AC)	1500	aged (w/S52, S52C, and S52AC)	2380
	conventional	aged (alone)	1420	aged (w/S52)	2310
	conventional	aged (w/S52AC)	1300		
% Elongation at 400 psi.	—	original	147	original	147
	modified	aged (alone)	71	Aged (w/S52, S52C, and S52AC)	81
NBS	modified	aged (w/S52AC)	71	—	—
	conventional	aged (alone)	68	aged (w/S52, S52C, and S52AC)	79
	conventional	aged (w/52AC)	66	aged (w/S52)	78
Ultimate, elongation, %	—	original	480	original	480
	modified	aged (alone)	170	aged (w/S52, S52C, and S52AC)	250
	modified	aged (w/S52AC)	180	—	—
	conventional	aged (alone)	230	aged (w/S52, S52C, and S52AC)	290
	conventional	aged (w/S52AC)	180	aged (w/S52)	280
Hardness, Shore A	—	original	67	original	67
	modified	aged (alone)	70	aged (w/S52, S52C, and S52AC)	75
	modified	aged (w/S52AC)	75	—	—
	conventional	aged (alone)	75	aged (w/S52, S52C, and S52AC)	75
	conventional	aged (w/S52AC)	74	aged (w/S52)	74

Results of these tests are given in Table 10. An examination of these data brings out several interesting points. What is perhaps the most important point is the fact that a vulcanizate cured with accelerators only (S52AC) and containing absolutely no antioxidant had much better aging resistance than a sulfur-cured compound (S52) containing two parts of antioxidant. In fact the addition of antioxidant did not substantially improve the accelerator-cured rubber from the aging standpoint, which point leads one to the conclusion that the type of curing system used is more important in obtaining good resistance to aging than use of antioxidant.

To show the effects of transference or migration of compounding ingredients between compounds aged simultaneously, some of the data in Table 10 were rearranged and are presented in Table 11. Only the compound possessing the poorest resistance to aging in this group (S52A-sulfur cured with zero antioxidant Table 10) gave evidence of transference effects.

The results in Table 11 indicate that S52A exhibits much less aging when aged in the presence of other compounds which contained *antioxidant*. When, for example, it was aged with S52AC, which contained no antioxidant, no improvement of aging was noted. It appears from these data that an extremely low level of antioxidant (as may be acquired through transference) is sufficient to protect a completely uninhibited sulfur-cured compound during this test.

Any effects due to transference could not be detected in the other three compounds. This was probably due to the fact that these compounds were not sensitive enough to the extremely small quantities of material which would be lost or gained by transference. Use of an aging test to determine transference in such compounds is not suitable for two chief reasons.

1. As shown in Table 9, even large increases in antioxidant cannot be detected by an aging test in a completely inhibited stock.

2. Compounds based on the sulfurless cure have such good aging properties that the minute quantities of ingredients transferred do not produce any apparent effects.

(To be continued)

Industrial Growth Rates

The annual growth rate in the rubber industry is now 5.44%, according to a recently released survey by the Stanford Research Institute. The growth rate of U. S. population is estimated at 1.13%, indicating that the use of rubber products in this country is growing five times faster than the population.

Other segments of the economy, however, are in more accelerated expansion. Industrial chemicals top the Institute's list with an annual growth rate of 10.78%. Transportation equipment follows with 8.56%, while general machinery manufacture is rated at 8.42%.

Some other annual growth rates are as follows: nonferrous metals, 6.57%; steel, 5.43%; paper and paperboard, 4.86%; paint, 4.55%; petroleum, 4.52%; construction, 3.63%; energy, 3.34%; and textiles, 2.39%.

[10] No. RR441, Kalper Switch, Microswitch Corp., Freeport, Ill.
[11] Prepared by Government Laboratories, University of Akron, Akron, O.

Factors Affecting Laboratory Cut-Growth Resistance of Cold SBR Tread Stocks[1]

By E. E. AUER, K. W. DOAK,[2] I. J. SCHAFFNER
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Important new relations between the laboratory crack-growth resistance of styrene-butadiene rubber vulcanizates and their modulus and breaking elongation have been established.

The logarithm of the cut-growth resistance is shown to be a linear function of modulus; the relation has important practical significance.

The elongation at break, however, appears to be the primary property governing cut-growth resistance. An equation which relates these properties has been derived. This relation is essentially independent of black loading, type of black, curing system, time and temperature of cure, antioxidant, and extent of aging.

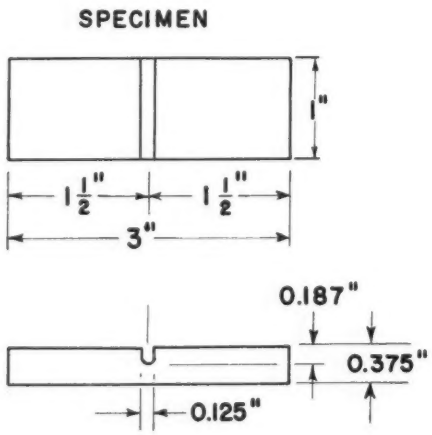


Fig. 1. Details of specimen used by U. S. Rubber for determining flex-cracking resistance on the modified De Mattia machine. Test conditions are as follows: angle of bend, 0 to 85 degrees; frequency, 287 cycles/min.; temperature, 80 to 150° F.; piercing needle, 0.037-inch in diameter

THE relatively poor groove cracking resistance of cold styrene-butadiene (SBR)[3] tread stocks is one of their principal defects. Groove cracking failures in tires involve the process by which small cracks, initiated by sharp objects or by ozone, grow in size as the tire is repeatedly flexed in service. The mechanism of fatigue cracking failures of this type is not clearly understood. Consequently agreement on methods of measuring crack-growth resistance in the laboratory and on techniques for making tread compounds less susceptible to groove cracking is not easy to attain.

A completely satisfactory mechanism must explain such failures in terms of certain fundamental properties of the stock, such as the stress-strain properties, hysteresis, rate and extent of crystallization (if any) of the polymer during stretching, oxidation resistance, and the like.

A major obstacle to investigations of the mechanism of fatigue cracking of rubber compounds has been the lack of reproducibility of the available tests. Thus, uncontrolled variations in the properties of the individual test specimens, particularly in the degree of cure as measured by the modulus (stress at 300% elongation), have been found in many cases to mask completely the effect of compounding variations. Similarly, uncontrolled variations in the testing procedure, such as differences in strain cycle due to slight irregularities in the way replicate samples are mounted in the test machine, further diminish the reproducibility of the test results. The difficulties involved in obtaining reproducible results in fatigue tests have been canvassed thoroughly by Buist (1)[4] and by Buist and Williams (2) in recent reviews of the subject.

The modified De Mattia cut-growth test that has been used in the laboratories of U. S. Rubber (3) for many years also suffers from the defects characteristic of flexcracking tests in general. Recently, however, it has been found possible to utilize this test in such a way that results having increased reproducibility and significance can be obtained. Of even greater interest is the fact that, by means of the improved testing procedure, a deeper insight can be obtained into the mechanism by which groove cracking takes place in cold SBR tread stocks.

This paper reports the use of an improved testing

[1] Presented before the Division of Rubber Chemistry, ACS, Atlantic City, N. J., Sept. 21, 1956. Contribution No. 163 from the General Laboratories, United States Rubber Co., Passaic, N. J.

[2] Present address: Koppers Co., Inc., Verona Research Center, Verona, Pa.

[3] ASTM Designation D 1418-56T for styrene-butadiene rubber now replaces GR-S or "Government Rubber-Styrene." American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

[4] Numbers in parentheses refer to Bibliography items at end of this article.



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technique to establish quantitative relations between cut-growth resistance and modulus, or between cut-growth resistance and ultimate elongation, of cold SBR stocks. Although the cut growth *vs.* modulus function is of practical importance, a more fundamental relation holds that the cut-growth resistance of cold SBR black stocks is largely determined by their elongation at break, regardless of other properties.

Details of the Improved Cut-Growth Test

The use of the new testing procedure in determining cut-growth resistance involves no change in the method of making individual measurements by means of the modified De Mattia machine. The sample and test conditions are shown in Figure 1. One-inch-wide test pieces are cut from a molded slab 6 x 3 x 0.375-inch, with a U-shaped groove 0.187-inch deep. Prior to testing, the center of the groove is pierced through with a needle 0.037-inch in diameter in order to initiate a cut. The samples are then flexed through an angle of 85 degrees at the rate of 287 cycles per minute until the cuts have grown to approximately ½-inch in length. The machine is so adjusted that the test pieces are in a position of zero strain at the beginning of each flexing cycle. The results obtained at room temperature (80 ± 5° F.) and 150 ± 3° F. are expressed as cut-growth resistance in kilocycles of flexing per inch of crack growth.

The usual method of characterizing the cut-growth resistance of a stock is to average the results obtained on a number of test pieces that have a state of cure considered optimum for the intended use of the compound under investigation. The reproducibility of such results usually is poor; an important cause is the difficulty of securing a precisely defined, highly reproducible state of cure. Even slight cure variations may produce large variations in the cut-growth resistance of the test

pieces, and this point is especially true of SBR stocks, whose fatigue properties are very sensitive to the state of cure.

The improved method, developed primarily for the purpose of minimizing the effect of uncontrolled variations in the state of cure, consists of determining the cut-growth resistance of each formulation over a very wide range of cures. The results are then plotted against some physical measure of the state of cure. When the modulus (stress at 300% elongation) is used as a measure of the state of cure, there results from every such test a band of points, each of which represents the cut-growth resistance and the modulus of an individual test piece. In spite of the error inherent in individual cut-growth measurements, it has been found that a curve fitted either graphically or by the method of least squares to the data thus obtained has a fairly high degree of reproducibility. From such a curve, the cut-growth resistance of a stock can be determined at any desired modulus value, with greater precision and significance than was possible previously.

In using the new method, modulus values are obtained in the usual manner on test pieces cut from slabs 6 x 6 x 0.1-inch that are prepared along with the cut-growth samples. Swelling measurements have shown that the modulus of the tensile test slabs is virtually identical with that of the rubber in the grooved region of identically compounded and cured cut-growth test pieces.

Relation Between Cut-Growth Resistance and Modulus

Although the primary purpose for developing the new testing procedure was simply to improve the reproducibility and increase the significance of cut-growth measurements, it soon became apparent that through this technique a relation between cut-growth resistance and modulus is disclosed that is in itself quite important and that could be used to study other factors which affect cracking.

For example, a conventional cold SBR tread stock containing 52 parts of a high abrasion furnace black was cured to various modulus levels as shown in Table 1. Modulus variations were obtained by varying the amounts of accelerator and sulfur and the curing time, separately or together. A semi-logarithmic plot of the cut-growth resistance (kilocycles per inch growth) *versus* the 300% modulus is shown in Figure 2. The results obtained at room temperature fall within a well-defined band; while the results obtained at 150° F. fall within a lower band. In each case the plot is nearly linear over the modulus range of 800-2800 psi, so that within this range the results can be expressed by the relation

$$\log (KC/in.) = a - b\,(M) \qquad (1)$$

where: KC/in. = cut growth resistance in kilocycles per inch.
M = 300% modulus in pounds per square inch.
a and b are parameters which are constants for a given stock at a given temperature.

The cut-growth resistance of SBR tread stocks has long been known to decrease with increasing cure, but by determining cut-growth resistance as a function of modulus over a wide range of cures, the logarithmic nature of the decrease becomes clearly evident. The

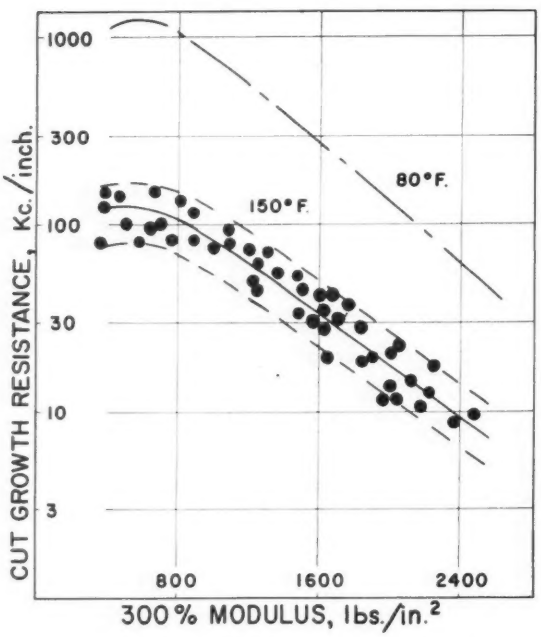


Fig. 2. Cut-growth resistance *versus* 300% modulus for SBR stock containing 52 phr. HAF black

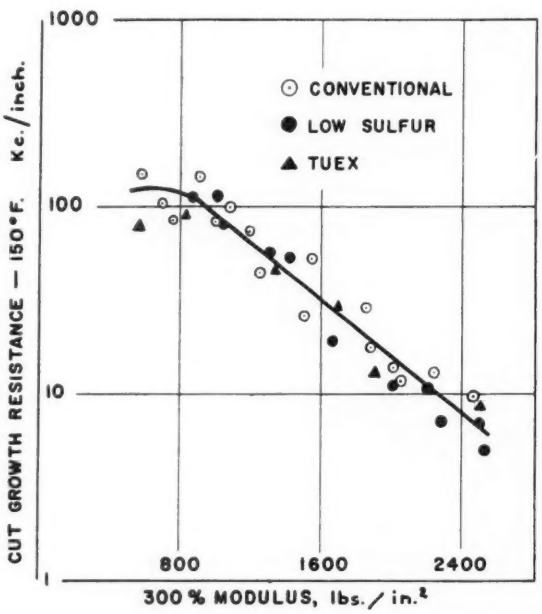


Fig. 3. Effect of type of cure on cut-growth resistance *versus* 300% modulus for SBR tread stock

data also reveal an unsuspected maximum in the cut growth *vs.* modulus relation and indicate that the cut-growth resistance of a SBR/HAF tread stock may be adversely affected if the state of cure is reduced to too low a value.

TABLE 1. COLD SBR COMPOUNDS

SBR 1500	100
Carbon black	52
Softener	6
Stearic acid	1
Zinc oxide	3
N,N′-diphenyl-p-phenylene diamine (JZF)	0.35
Mercaptobenzothiazole	0.6 to 1.0
Diphenylguanidine	0.3 to 0.6
Sulfur	1.0 to 3.5

Blacks: HMF, FEF, HAF, SAF

Cure: 30 to 120 minutes at 274° F.

Similar curves, but with different parameters are obtained using equilibrium modulus values measured at 300% or 100% elongation. For simplicity, however, first pull values at 300% extension were used in all data reported here.

From the data in Figure 2 and from similar data at other temperatures, the temperature coefficient of crack propagation can be determined at any modulus level. Thus at a modulus of 1200 psi. the rate of crack growth approximately doubles with every 21° F. (12° C.) rise in temperature between 80° and 150° F., and the cut-growth resistance at 150° F. is only about 1/10 that at 80° F. This temperature coefficient agrees well with that recently obtained by Buist (1) for SBR tread stocks with a Flipper machine (4). The temperature coefficient varies somewhat with the modulus and, at any given modulus value, with the type of filler used.

Insensitivity of Cut Growth-Modulus Relation To Compounding and Curing Variables

To obtain the extensive modulus variations required by the procedure described above, it is necessary to vary the accelerator and sulfur concentrations in the stock or the curing time, individually or simultaneously. The question immediately arises as to whether these curing variations themselves influence the cut-growth resistance of the vulcanizates. Generally speaking, a SBR stock can be brought to a given modulus by using any one of a variety of curing systems and curing conditions in conjunction with one another. If however, the cut-growth resistance corresponding to a given modulus depends upon the way in which the modulus is obtained, it is clear that reproducible relations between cut-growth resistance and modulus will be difficult to obtain.

For this reason it was necessary to compare the cut-growth *vs.* modulus relations of tread stocks that are identical except for the method used to vary the modulus. These cold SBR stocks were all prepared from the same masterbatch containing 52 parts of high abrasion furnace (HAF) black. The formulations, shown in Table 2 include: (a.) a conventional curing system with varying amounts of sulfur and accelerator and varying curing times and temperatures; (b.) a highly efficient low sulfur vulcanizing system with a high accelerator content and with varying sulfur levels and curing times; (c.) a non-sulfur curing system using tetramethylthiuram disulfide, with varying curative levels and curing times.

TABLE 2. CURING SYSTEMS FOR SBR HAF BLACK STOCK

SBR 1500	100		
HAF black	52		
Softener	6		
Stearic acid	1		
Zinc oxide	3		
	Conventional	Low Sulfur	Tuex
Mercaptobenzothiazole	0.6–1.0	—	—
Diphenylguanidine	0.3–0.6	—	—
Tetramethylthiuram sulfide*	—	1.5	—
Sulfur	1.0–3.5	0.35–1.25	—
Tetramethylthiuram disulfide†	—	—	1.5–10.0

Cure: 30 to 120 minutes at 274° F.
15 to 90 minutes at 293° F.

*Monex, Naugatuck Chemical trade mark.
†Tuex, Naugatuck Chemical trade mark.

Figure 3 shows that, within the limits of experimental error, the cut-growth *vs.* modulus relations for any given tread stock is independent of wide variations in the curing system and in the curing conditions.

Effect of Antioxidants on Cut-Growth Resistance

Evidence has accumulated which indicates that oxidation during flexing is a contributing factor in cut-growth and fatigue failure of *Hevea* rubber stocks. Flexcracking failure occurs much more rapidly in the presence of air than in nitrogen, and antioxidants such as a diphenylamine-acetone reaction product,[5] N,N′-diphenyl-p-phenylene-diamine,[6] or phenyl-beta-naphthylamine (PBNA) improve flexcracking resistance markedly (5). On the other hand, any improvement in the flex-cracking resistance of SBR stocks due to antioxidants was not detected by previous test methods (6-8). It was of interest, therefore, to determine whether the effect of antioxidants could be detected by their effect on the more sensitive cut-growth-modulus relation of SBR stocks.

In one set of experiments, PBNA or BLE in combination with JZF were added to an antioxidant-free SBR containing 52 parts of HAF black. The polymer used was a special batch coagulated and dried at low temperature in order to prevent gel formation, since the presence of gel as a result of inadequate stabilization of SBR has been shown to reduce cut-growth resistance (8). The stocks were cured by the vulcanizing system shown in Table 1, and the amounts of antioxidants are shown in Figure 4. Modulus range was obtained by varying sulfur from 1.0 to 3.5 parts.

The results obtained at room temperature, shown in Figure 4, reveal a slight, but significant upward shift in the plot of log KC/in. *vs.* modulus, due to the incorporation of antioxidants. A smaller shift is observed for results obtained at 150° F. Thus, addition of small

[5]BLE, Naugatuck Chemical Division, U. S. Rubber, trade mark.
[6]JZF, Naugatuck Chemical Division, U. S. Rubber, trade mark.

amounts of antioxidants improves very slightly the cut-growth resistance of otherwise antioxidant-free cold SBR tread stocks. In other experiments, not shown in detail, the addition of up to 4.0 parts of PBNA to a stock already containing the normal amount of antioxidant gave no further improvement in the cut-growth resistance.

These observations lead to the conclusion that the oxidation of SBR in the growing crack during the cut-growth test is not an important factor in crack propagation, in contrast to the behavior of natural rubber. The absence of specific effects of antioxidants on cut-growth resistance of unaged SBR vulcanizates is in agreement with the previously cited observations.

Insensitivity of the Cut Growth-Modulus Relation To Aging

During air aging at elevated temperatures, several chemical reactions affecting the modulus of rubber compounds occur simultaneously. Some of the reactions tend to increase the modulus. Among these are the formation of new cross-links due to oxidation reactions and the formation of additional sulfur cross-links due to combination of residual free sulfur with the rubber. On the other hand, chain-scission reactions simultaneously decrease the modulus.

In the case of SBR vulcanizates, cross-linking reactions which increase modulus predominate (9). This physical change reflects not only a net increase in the density of cross-links, but, equally important, a change in the kind of cross-links. The new cross-links formed during aging are generally considered to consist of both carbon-oxygen and carbon-carbon bonds, formed as a result of free-radical oxidation reactions.

The fatigue-cracking resistance of SBR vulcanizates is known to decrease rapidly during aging (10). In view of the data already presented in this paper, it would seem quite possible that the loss of cracking resistance during aging is simply a function of the increase in the modulus of the stock. It is also possible, however, that the change in the chemical nature of the cross-linked network referred to above might establish in the aged stock a structure that is inherently poor in flexcracking resistance. According to the latter view, an aged stock would exhibit a much lower cut-growth resistance than does an unaged stock having the same modulus.

By determining the cut-growth-modulus relations of SBR stocks before and after aging, it is readily possible to distinguish between these two mechanisms. If the loss in fatigue resistance during aging is due simply to the increase in the number of cross-links, irrespective of their chemical character, then the cut-growth resistance for both aged and unaged stocks will obey the same logarithmic modulus relation. But if the change in the chemical nature of the cross-links is important, the cut-growth resistance for aged stocks will deviate significantly from that of unaged stocks having the same modulus.

Such an investigation was carried out on the SBR tread stock containing 52 phr. of HAF black, shown in Table 1. Cut-growth resistance was determined as a function of modulus for unaged vulcanizates and for the same stocks after two and four weeks of aging in circulating air at 158° F. (Geer aging). The data shown in Figure 5 reveal that as aging progressed, the modulus of the vulcanizates increased markedly, but the cut-growth resistance was affected only to the extent that the modulus increased. After the samples were aged two

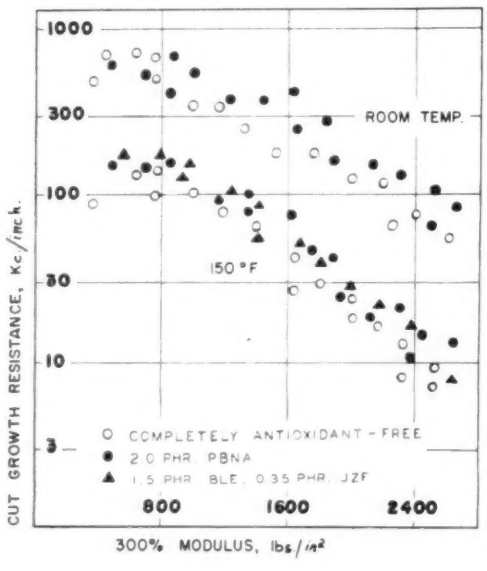


Fig. 4. Effect of antioxidants on cut-growth resistance *versus* 300% modulus for SBR/HAF black stock

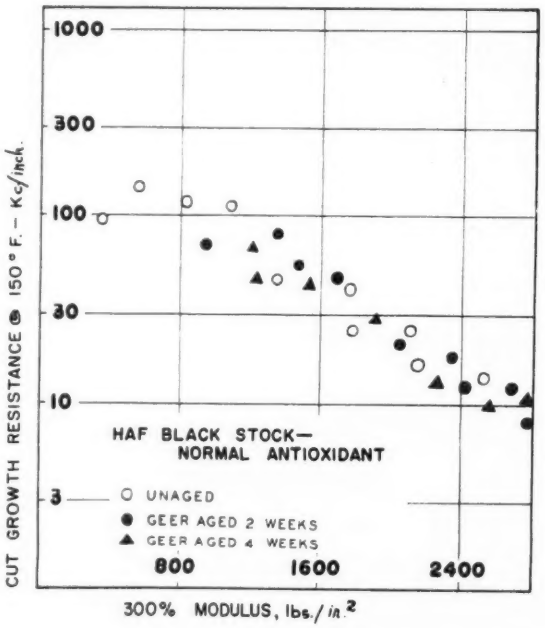


Fig. 5. Effect of Geer aging on cut-growth resistance *versus* 300% modulus for SBR/HAF black stock containing normal antioxidant

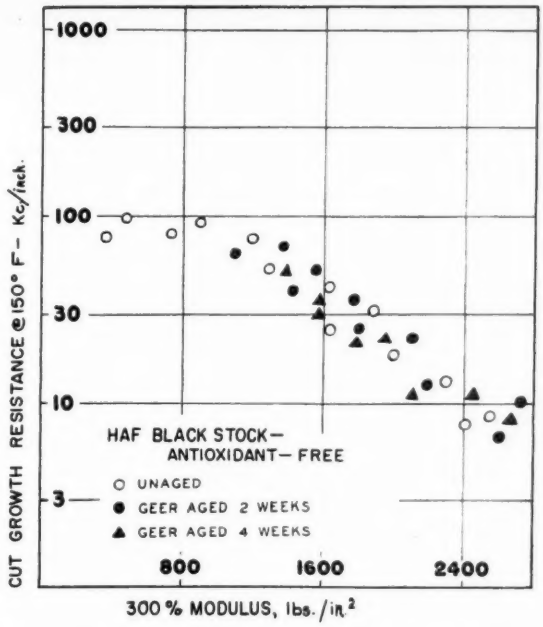


Fig. 6. Effect of Geer aging on cut-growth resistance *versus* 300% modulus for SBR/HAF black stock containing no antioxidant

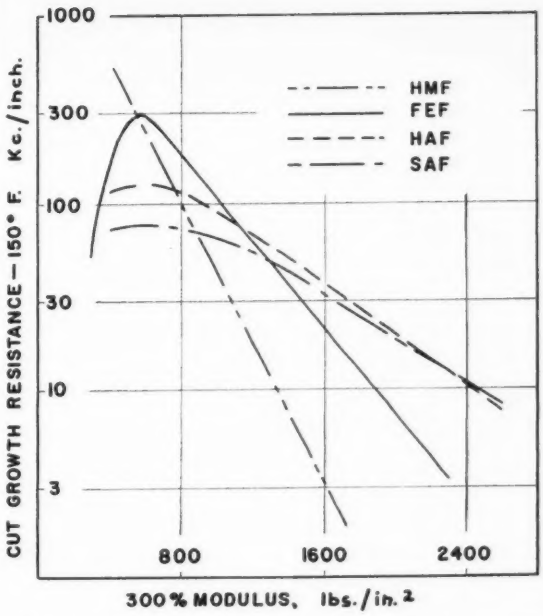


Fig. 7. Effect of type of carbon black on cut-growth resistance *versus* 300% modulus in cold SBR tread stocks

and four weeks, the plot of log (KC/in.) *vs.* 300% stress coincides with that characterizing the unaged samples. During Geer aging, changes in the chemical nature of the network structure of the vulcanizate evidently have no effect on cut growth in this SBR formulation. Similar results have been obtained in studies of other types of SBR tread stocks.

The insensitivity of the cut-growth-modulus relations to aging, however, might be due to the effect of antioxidant in the stock. As aging progresses, the concentration of antioxidants originally present gradually decreases, but it seemed possible that even after several weeks of Geer aging, enough residual antioxidant might remain to affect the nature of the results. The preceding experiment was therefore repeated with the specially prepared stock completely free of antioxidant, described in the preceding section. The cut growth-modulus relation was determined before aging and after two and four weeks of Geer aging. The results, shown in Figure 6, are similar to those obtained with stocks containing a normal amount of antioxidant, shown in Figure 5. Thus in both cases the effect of Geer aging on cut-growth is that caused by the increase in modulus, and the benefit of antioxidant stabilizers on the cut-growth resistance of SBR vulcanizates is due only to the prevention of inordinately large increases in modulus.

Various Types of Carbon Blacks in Cold SBR Tread Stocks

The improved testing technique was employed in a comparison of different types of carbon black in cold SBR tread stocks. Formulations involving four different types of furnace blacks at loadings of 52 phr., but otherwise similar, are shown in Table 1. In each case variations in the state of cure over a very wide modulus range were obtained by varying the acceleration, sulfur, and the curing time. A single blend of SBR was used for all masterbatches. Carbon black, zinc oxide, and softeners were incorporated in a laboratory "B" Banbury mixer; the discharge temperature, after a 10-minute mixing cycle, was 285-300° F. The remaining ingredients were incorporated on a mill.

Figure 7 shows the cut-growth *vs.* modulus curves obtained at 150° F. for each of the formulations of Table 1. It will be understood that each curve represents a band of data similar to those in Figures 2-6. The results show that in the modulus range of 800-2800 psi. each type of black gives a logarithmic relation between cut-growth resistance and modulus, of the type represented by Equation 1. Different blacks, however, give curves with different slopes; so the relative ratings of the compounds depend upon the modulus at which they are compared. The reason for confusion about the relative ratings of different blacks in SBR undoubtedly lies in the fact that cross-overs exist in the cut-growth-modulus curves. Thus, HMF and FEF blacks give the best cut-growth resistance at low modulus levels; in the range normally used for tires, HAF and SAF are superior; while at very high modulus (2000 psi. or more) SAF black may be best.

The cut growth *vs.* modulus relation for stocks containing the finer furnace blacks (FEF, HAF, SAF) tends to exhibit maxima at 300% moduli in the vicinity of 600 psi. For these stocks the linear logarithmic relation between cut-growth and modulus appears to break down at low modulus values. For stocks that

contain larger particle size blacks, such as SRF (semi-reinforcing furnace), there is usually no breakdown in the linear relation, even at very low modulus. These observations will receive more attention later on.

Although not shown in Figure 7, the curves representing the cut-growth behavior of the different blacks at room temperature are, generally speaking, similar to those obtained at 150° F. except that the cut-growth resistance values obtained at any given modulus level are roughly 7-10 times as great at room temperature as they are at 150° F.

TABLE 3. SLOPES AND INTERCEPTS OF CUT GROWTH-MODULUS CURVES FOR DIFFERENT BLACKS*

	Value of Parameters			
	At Room Temperature		At 150° F.	
Black	a	b(x10²)	a	b(x10²)
HMF (Kosmos 40)†	4.17	1.47	3.52	1.90
FEF (Philblack A)‡	4.57	1.29	3.20	1.16
EPC (Wyex)§	3.39	0.91	2.44	0.77
MPC (Spheron #6)¶	3.77	1.12	2.39	0.68
HAF (Philblack O)‡	3.67	0.74	2.59	0.64
SAF (Philblack E)‡	3.11	0.58	2.44	0.59

*Values of the parameters, a and b, Equation 1, for linear portion of curves. Blacks listed in order to decreasing values of b at 150° F.
†United Carbon Co. trade mark.
‡Phillips Chemical Co. trade marks.
§J. M. Huber Corp. trade mark.
¶Godfrey L. Cabot, Inc., trade mark.

The experiments just described can be extended to include other blacks. The blacks tested can then be compared with respect to the slopes and intercepts of the linear portion of the cut-growth-modulus curves that characterize the formulations in which they are present. Numerical values of these parameters, designated as a and b in Equation 1, have been calculated both at room temperature and 150° F. for stocks having six different types of black at loadings of 52 phr. The results are shown in Table 3. From these values, the laboratory cut-growth resistance of any of the stocks can be calculated with a fair degree of accuracy at any modulus value over the linear range (between 800-2800 psi.) through substitution in Equation 1.

The value of the parameter, b, shows in each case the logarithmic decrease in the cut-growth resistance brought about by a unit increase in the 300% modulus; these values are thus a measure of the sensitivity of the cut-growth resistance of the various stocks to changes in modulus, regardless of whether the modulus variations are brought about by curing or aging mechanisms.

Effect of Black Loading

The results so far discussed apply to cold SBR tread stocks having a conventional black loading (52 phr.). It is of interest to determine how the cut-growth *vs.* modulus relation is affected by substantial variations in black loading. Although other types of black (including channel blacks) have been investigated as well, the results obtained when the HAF black loading in the formulation of Table 1 is varied from 0 to 100 parts per hundred of rubber are typical and are shown in Figure 8. When cut-growth resistance is plotted as a function of modulus, a band of points is obtained that is characteristic for each loading. These bands (and the curves which are fitted to them) show an interesting progression which covers a very great range of cut-growth values as the black loading and the modulus are varied from very low to very high values. For modulus levels in excess of

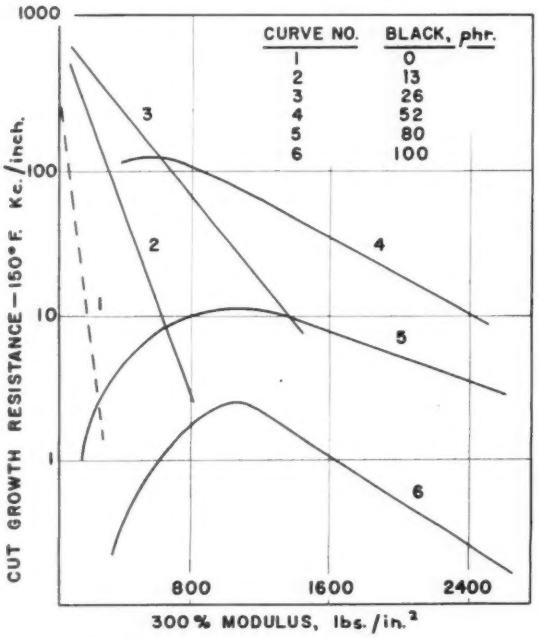


Fig. 8. Effect of HAF black loading on cut-growth resistance *versus* 300% modulus

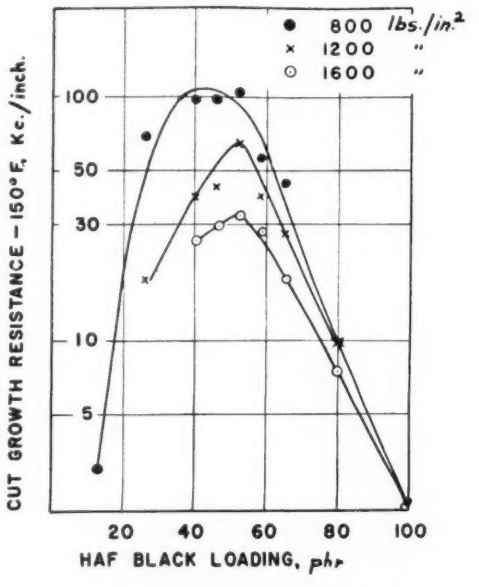


Fig. 9. Cut-growth resistance as a function of HAF black loading at various 300% moduli

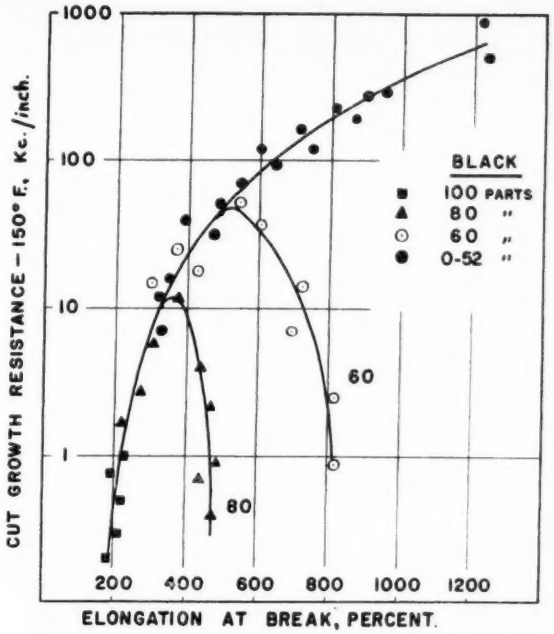


Fig. 10. Cut-growth resistance *versus* elongation at break for SBR/HAF black stocks

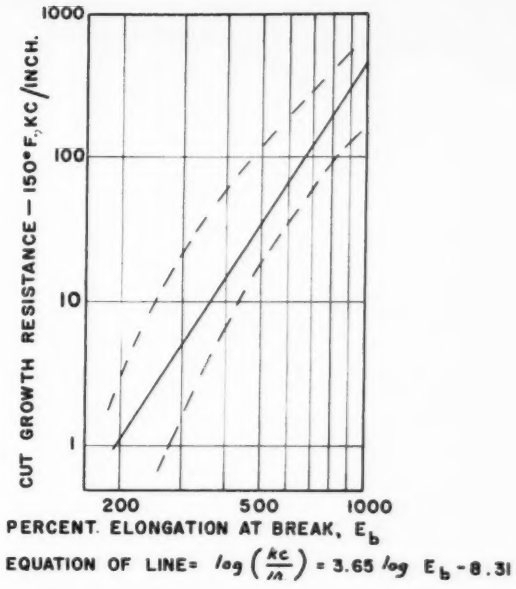


Fig. 11. Cut-growth resistance *versus* elongation at break as log-log plot

1000 psi. each curve approximates the relation expressed by Equation 1, except that the parameters, a and b, vary greatly with black loading.

At low black loadings this linear logarithmic relation holds true down to the lowest modulus levels that were obtained experimentally. At a black loading of 52 phr., however, the linear relation appears to break down at low modulus values. At black loadings of 80 and 100 phr. the linear relations are transformed into curves with well-defined maxima, followed by a sharp decrease in cut-growth resistance as the modulus is progressively decreased below about 1000 psi.

The curves of Figure 8 can be used to determine the cut-growth resistance as a function of the loading of HAF black at any modulus level. Constructed with data taken from Figure 8, Figure 9 shows cut-growth resistance as a function of black loading for modulus levels of 800, 1200, and 1600 psi.; a separate curve is obtained at each modulus. These curves reveal that for any given modulus level there exists a narrow range of black loadings within which the cut-growth resistance of the vulcanizates is a maximum. For SBR/HAF stocks having a normal tire cure, this optimum range lies between approximately 45 and 55 phr. of black. Groove-cracking resistance decreases rapidly as the black loading departs, in either direction, from this range.

From a theoretical point of view it seems perhaps surprising that the curves of Figure 9 should exhibit maxima. It is possible, however, to demonstrate that the form of these curves is directly related to the stress-strain characteristics of the stock. The explanation arises from the connection that has been found to exist between the cut-growth resistance and the breaking elongation. This new relation will now be considered.

Cut-Growth Resistance in Relation to Elongation At Break

The relation between cut-growth resistance and modulus in cold SBR stocks at 150° F. has been shown to be dependent on the type of black used and greatly dependent on the black loading. On the other hand, the relation has been found to be virtually independent of substantial variations in the curing system, temperature and time of cure, antioxidant concentration, extent of air aging, etc. These conclusions suggest that the cut-growth resistance of SBR stocks, although related to their moduli, may be even more fundamentally related to some other physical property, in terms of which there will result an expression for cut-growth resistance that is independent of the type of black and the black loading.

Figure 10 shows that such a property is the elongation at break measured at room temperature. If the cut-growth values used in obtaining Figure 8 are plotted against the breaking elongation of the corresponding vulcanizates instead of against their 300% modulus values, the data for the varying black loadings all fall within one single band, independent of black loading (if, for the moment, we exclude the data for stocks having very high black loadings *and also* very low cures). Although the data shown in Figure 10 are for SBR/HAF stocks, the relation there indicated has been shown to be essentially independent of the type of black used.

A system of curves can be fitted to the data of Figure 10 which consists of a main spine, with descending branches at 60 and 80 phr. of black. These descending branches are caused by highly loaded stocks cured to very low moduli and reflect the deviations of the corresponding cut-growth *vs.* modulus curves from the logarithmic relation (Figure 8). Actually, the cut-growth *vs.*

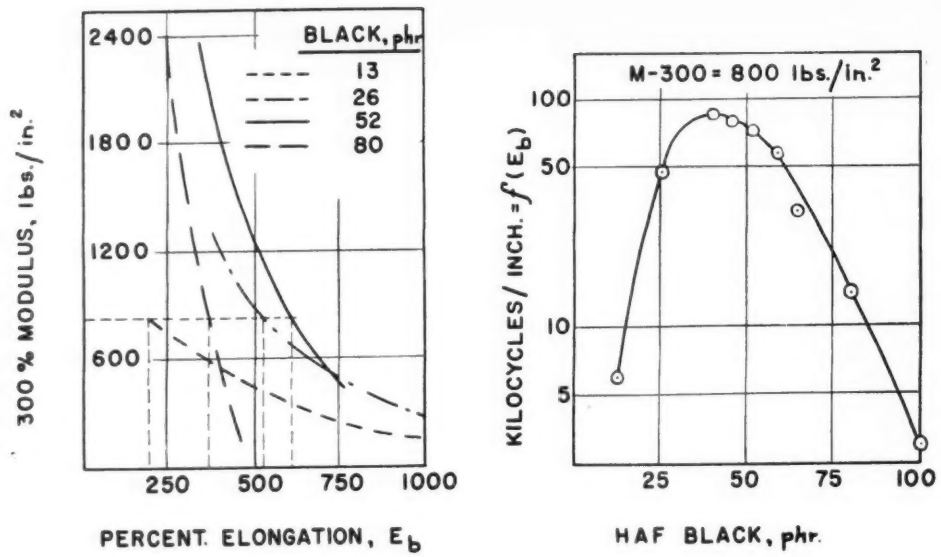


Fig. 12. A, *left*, 300% modulus *versus* elongation at break—effect of HAF black loading; B, *right*, calculated cut-growth resistance *versus* HAF black loading

elongation relation for the stock having 100 phr. of black also has a descending branch, but the latter falls within the band characterizing the main spine.

The behavior of stocks with high loadings and also low states of cure suggests that the main spine of Figure 10 actually represents the envelope of a series of cut-growth *vs.* breaking elongation curves, each of which passes through a maximum as the breaking elongation diminishes from a high value (at a low state of cure) to a low value (at a high state of cure). The location of these maxima seems to move to the right along the envelope as the black loading diminishes. For black loadings of 50 phr. or less, the location of the maxima presumably occurs at such low states of cure as to be virtually impossible to detect experimentally.

When black stocks, regardless of black loading, are all cured to a 300% modulus of 800 psi. or more, the descending limbs do not appear, and the cut-growth *vs.* breaking elongation data all fall within the main band of Figure 10. Figure 11 shows that on a log-log plot, this band is almost linear. It can then be approximately represented by a straight line having the equation:

$$\log (KC/in.) = 3.65 \log E_b - 8.31 \quad (2)$$

$$\text{or } (KC/in.) = E_b^{3.65}/2.04 \times 10^8 \quad (3)$$

where: (KC/in.) = cut growth resistance at 150° F. in kilocycles per inch.

E_b = the breaking elongation as measured on the Scott machine[7] at room temperature.

It should be emphasized that the above equations apply only to results obtained on the modified De Mattia machine when operated as indicated in Figure 1.

It is recognized that correlations between crack-growth resistance measured at 150° F. have been made with stress-strain properties measured at room temperature. If cracking resistance and stress-strain measurements were both made at the same temperature, the constants shown in Equations 2 and 3 would undoubtedly be altered somewhat; also, the experimental data might more closely approximate a linear relation on the log-log plot.

Calculation of Cut-Growth Resistance from Measurements of Elongation at Break

Equation 3 signifies that the cut-growth resistance of any cold SBR tread stock in this test can be calculated if the breaking elongation of the stock is known. While this statement applies without qualification only if stocks having both very high black loadings and very low states of cure are excluded, it holds for all practical tread vulcanizates since these are usually cured to 300% modulus values of 800 psi. or more.

Equation 3 can be used to explain the maxima which characterized the curves of Figure 9. Thus, the procedure for calculating the cut-growth resistance as a function of carbon black loading in cold SBR/HAF tread stocks cured to a 300% modulus of 800 psi. is summarized in Table 4, and the results are shown in Figure 12.

The first step is to determine, over a wide range of cures, the stress-strain properties of stocks having amounts of HAF black. The 300% modulus is then plotted against the breaking elongation, as shown in Figure 12A. From each of these curves, the breaking elongation that corresponds to a 300% modulus of 800 psi. is then determined. Finally, these breaking elongations are substituted into Equation 3, and the calculated

[7] Scott Testers, Inc., Providence, R. I.

cut-growth resistance values are plotted against the corresponding black loadings, as indicated in the curve in Figure 12B. This curve is seen to have the general features of the corresponding curve in Figure 9, and the calculated cut-growth resistance values do not differ greatly from those obtained experimentally.

TABLE 4. CALCULATION OF CUT-GROWTH RESISTANCE AS FUNCTION OF HAF BLACK LOADING IN TREAD STOCKS CURED TO 800 PSI. MODULUS

Black Loading (Phr.)	% Breaking Elongation of Stock When 300% Modulus Is 800 Psi.	Calculated 150° F. Cut-Growth Resistance in Kilocycles per Inch (Equation 3)
0	—	—
13	320	7
26	540	46
40	650	91
46	640	86
52	625	79
58	590	64
65	500	35
80	375	12
100	230	2

Summary and Conclusions

By using an existing cut-growth test in a new way it has been possible not only to increase the reproducibility of the results, but also to show important relations between cut-growth resistance and modulus, or the elongation at break of cold SBR tread stocks.

The logarithm of the cut-growth resistance of cold SBR vulcanizates as measured on a modified De Mattia machine, is shown to be a linear function of the 300% modulus, except for certain undercured stocks. The slope of the curve is dependent on the type and the amount of black, but is relatively independent of the type of curing system, amount of antioxidant, and time of Geer aging.

An equation has been found which relates cut-growth resistance at 150° F. with the elongation at break of the vulcanizate. Except for stocks having black loadings in excess of about 55 phr. and having in addition modulus values less than 800 psi., this relation appears to be nearly independent of black loading, type of black, curing system, time or temperature of cure, antioxidant concentration, and extent of Geer aging.

The elongation at break of an SBR tread stock thus appears to be a primary factor governing its groove-cracking behavior. The relation between cut-growth resistance and modulus is of secondary significance and evidently depends upon the interrelation between the modulus and breaking elongation of these formulations. The breaking elongation, however, cannot be the sole factor governing the groove-cracking behavior; otherwise there would be no restrictions on the validity of the breaking elongation equation.

The authors wish to express their appreciation to Drs. L. M. White and B. C. Barton for their advice and encouragement during this work and to T. L. Prendergast for assistance with the laboratory measurements.

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Chemists Get New Words on Polymer Spatial Arrangement

Three new words to describe different arrangements of atoms in certain long-chain molecules have recently entered the vocabulary of polymer chemists. Coined by Professor Giulio Natta, of Polytechnic Institute, Milan, Italy, they are "isotactic," "syndyotactic," and "atactic".

In most cases, different spatial arrangements of the same polymer will result in different physical properties. The difference is often pronounced. Research projects are currently under way both in the United States and abroad with the objective of tailoring spatial arrangements of polymers for specific end-uses through utilization of suitable catalysis.

Isotactic, according to Professor Natta, is the arrangement of molecular groups substituted for atoms in a long-chain polymer either all above or all below the main plane of the polymer.

Taking ethylene as an example, a section of its polymer may be depicted like this:

$$-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-$$

One of the hydrogen atoms in ethylene may be replaced by a group, R. When a substituted ethylene polymerizes, a section of the chain may be represented as:

$$—CH_2—CH(R)—CH_2—CH(R)—CH_2—CH(R)—$$

Obviously the R groups may be positioned differently. An isotatic arrangement, therefore, occurs when all of the R groups lie either above or below the main plane of the polymer; this represents a highly ordered structure.

Syndyotactic, another highly ordered structure, occurs when the R groups alternate above and below the main plane.

The third term, atactic, is applied to the polymer when the positioning of the R groups is random.

MEETINGS and REPORTS

ASTM Committee D-11 February Meeting: Material Definitions, Research Discussed

There was a meeting of Committee D-11 and many of its subcommittees of the American Society for Testing Materials as part of the Society's Committee Week in Philadelphia, Pa., during the week of February 4. Matters of primary concern of Committee D-11 included rubber research problems that might be considered by the Society's Research Committee, a request for a more precise definition of "rubber-like materials" with special reference to urethane foams, and plans for participation in the International Rubber Technology Conference, scheduled for the Fall of 1959, and the meeting of the International Standards Organization, Technical Committee 45 on Rubber, scheduled for this country at about the same time.

Committee D-11 Meeting

The meeting of Committee D-11, held the morning of February 8, was preceded by meetings of several subcommittees. H. G. Bimmerman, D-11 vice chairman, presided at this meeting in the absence of Chairman Simon Collier, Johns-Manville Corp., and was assisted by D-11 secretary, J. J. Allen, Firestone Tire & Rubber Co.

Recent new appointments in the Committee were first announced as follows: chairman of subcommittee 6 on packings, R. F. Anderson, B. F. Goodrich Co.; chairman of subcommittee 18 on flexing tests and representative on ISO/TC 45, group 13, Howard Tannenberg, Goodrich; chairman of subcommittee 9 on insulating tape and D-11 representative on Committee 59 of the American Standards Association, C. W. Pickells, Consolidated Edison Co. of New York, Inc.; D-11 representative on ASA Committee C-8, R. A. Schatzel, Rome Cable Corp.; D-11 representative on subcommittee 2 of ASTM Committee E-1, Joseph Breckley, Titanium Pigment Corp.; and D-11 representative on the ASTM Research Committee, J. H. Ingmanson, Whitney Blake Co.

A coordinating committee has been formed on cellular materials or foams made from rubber, rubber-like, and plastic materials which includes representation from ASTM Committees D-9 on Electrical Insulating Materials, D-10 on Shipping Containers, D-11, D-20 on Plastics, the ASTM-SAE Technical Committee on Automotive Rubber, the Society of the Plastics Industry, and the Society of Plastics Engineers. F. Y. Speight, ASTM headquarters staff, is chairman of this committee.

A request has been received from the foam coordinating committee by D-11 for a more precise definition of the term "rubber-like materials." A three-man task group in D-11 headed by L. V. Cooper, Firestone, will study this problem and report to D-11 at the June, 1957, meeting.

It was announced also that a new chairman would be appointed for D-11 subcommittee 8 on nomenclature and definitions, and that comments on the "Glossary of Terms Relating to Rubber and Rubber-Like Materials," ASTM Special Technical Publication No. 184, will be referred to this subcommittee.

J. H. Ingmanson, D-11 representative on the ASTM Research Committee, requested rubber research problems from D-11 members for consideration by this ASTM committee.

A representative from D-11 will be appointed for the ASTM Committee E-10 on Radioisotopes and Radiation Effects.

Mr. Bimmerman will be chairman of the committee on arrangements, and R. D. Stiehler, National Bureau of Standards, vice chairman, for the meeting in the United States in the Fall of 1959 of the ISO/TC 45 Committee. This meeting will probably precede the International Rubber Technology Conference being sponsored by ASTM D-11, the Rubber Division of the American Chemical Society, and the Rubber & Plastics Division of the American Society of Mechanical Engineers, scheduled for Washington, D. C., November 8-13, 1959.

It was announced that the Society plans to revise the format of the ASTM specifications, and any comments in this connection should be addressed to P. J. Smith at ASTM headquarters. Also, the "1958 Book of Standards, Part 6, Plastics, Electrical Insulation, Rubber, and Electronics," will probably have to be divided into at least two parts because of the increasing volume of published material. Comments on this action are also invited by Mr. Smith.

Subcommittee Meetings

Subcommittee 1—Hose. R. A. Bonnell, Goodyear Tire & Rubber Co., chairman. This subcommittee did not hold a meeting, but the chairman recommended for letter-ballot in Committee D-11 an extensive revision of D 380-51T, Methods of Test for Rubber Hose.

Many of these changes in D 380-51T were detailed in the report of the June, 1956, meeting of this subcommittee.[1]

Subcommittee 5—Wire and Cable. John T. Blake, Simplex Wire & Cable Co., chairman. Reports were presented on progress made toward writing specifications for synthetic braids and the newer types of polyethylene when these items are used in electrical insulation.

Several changes in present specifications for wire and cable were discussed, and these changes will be submitted to letter-ballot in the subcommittee.

The matter of having dimensional tolerances specified on a statistical rather than an absolute value basis was discussed at some length; material from the Insulated Power Cable Engineers Association was used as a source of information. Continued discussion of this problem is planned for the next meeting of the subcommittee.

Subcommittee 6—Packings. R. F. Anderson, chairman. D 1081-49T, Method of Test for Evaluating Pressure-Sealing Properties of Rubber and Rubber-Like Materials, was reviewed. This standard is used also by the Navy Department as Method 3211 in Federal Specification 601. In view of work being done on another apparatus for this test it was decided to recommended the ASTM standard remain as tentative.

The negative letter-ballots on D 733-53T, Method of Test for Compressed Asbestos Sheet Packing, were resolved by correspondence, and the revised method will now appear in the new Committee D-11 handbook.

A report on the round-robin program on stress-relaxation measurements now under way in section 10C of the SAE-ASTM Technical Committee on Automotive Rubber was made. The work being done on sealibility in this same group and the development of a new test apparatus, as mentioned above in connection with D 1081-49T, were also explained.

A recently developed corrosion test procedure will be circulated within the subcommittee for study and consideration for inclusion in D 733-53T.

[1] RUBBER WORLD, July, 1956, p. 569.

Subcommittee 9—Insulating Tape. C. W. Pickells, chairman. Revisions of D 69-52T, Specifications for Friction Tape for General Use for Electrical Purposes; D 119-48T, Specifications for Rubber Insulating Tape; and D 1373-55T, Specifications for Ozone Resistant Rubber Tape, were recommended for letter-ballot in Committee D-11.

It was decided that there was a need of a moisture-resistance requirement in the rubber tape specifications, and a task group will be appointed to develop test methods and acceptable specification limits.

Subcommittee 10 — Physical Testing. L. V. Cooper, chairman. The task group on proper clamps for testing O-rings has determined that single-roller clamps with power rotation of the lower grip roller were preferred by the majority of 45 persons replying to a questionnaire on this subject. A comparison of single- *versus* double-roller clamps will be made.

As an interim guide, the subcommittee agreed to the insertion of a footnote in D 412-51T, Tension Testing of Vulcanized Rubber, in connection with ring specimens, as follows:

"Extensive investigation in January, 1957, revealed that most users of ring test specimens were testing with a single spool on each clamp with the lower spool being power rotated."

A task group was appointed to study the subject of equivalent cure between slabs for tensile strength testing and slabs for compression set determinations, or products of irregular contour.

The task group on tensile machine calibration promised a report of its investigation at the June, 1957, meeting.

Subcommittee 11 — Chemical Analysis. W. P. Tyler, Goodrich, chairman. This subcommittee has been asked to develop standard test methods for the analysis of rubber chemicals, limiting this work at present to accelerators and antioxidants. A task group for work on this project was appointed.

The test method for the determination of mixed alkylated phenols in styrene-butadiene rubbers (SBR), of interest particularly to subcommittee 13 on synthetic elastomers, has been found not to be entirely satisfactory. B. C. Pryor, Goodrich-Gulf Chemicals, was requested to form a task group under the jurisdiction of either subcommittee 10 or 13 to restudy this method.

A report on the determination of carbon black in rubber compounds by the pyrolysis method indicated progress, but sufficient data have not become available as yet to permit development of a tentative test method.

Test programs have been organized for work on a proposed method for the rapid determination of zinc in rubber compounds and for work on a rapid extraction method for rubber and rubber compounds.

A request for work on a method for the determination of soluble sulfates and chlorides in insulating rubber sheet will be taken under advisement until such time as a task group can be organized.

Subcommittee 12—Crude Natural Rubber. Norman Bekkedahl, National Bureau of Standards, chairman. There was no meeting of this subcommittee, but the chairman asked that D 1278-53T, Method Test for Harmful Dirt in Crude Natural Rubber, be continued as tentative. The ISO/TC 45 on Rubber is studying D 1278-53T and may suggest modifications that might be considered for incorporation into this method.

Subcommittee 13—Synthetic Elastomers. B. S. Garvey, Jr., Sharples Chemicals Division, Pennsylvania Salt Mfg. Co., chairman. The subcommittee recommended for letter-ballot in Committee D-11 the "Proposed ASTM Sampling Method and Sample Preparation for Styrene-Butadiene Rubbers (SBR)," after modification of this proposed method in line with the results of the recent subcommittee letter-ballot.

Although D 1416-56T, Methods of Chemical Analysis of Synthetic Elastomers, has now been published, the task group on chemical analysis is continuing work on methods for the determination of ETA extract, oil content, antioxidant, and mixed alkylated phenol-type antioxidant in SBR.

The task group on physical testing reported that work of this nature for subcommittee 13 was being done in subcommittee 29 on compounding ingredients, and members of subcommittee 13 interested in this work should inform the secretary of Committee D-11.

The task group on latices recommended that subcommittee 13 ask Committee D-11 to letter-ballot substitution of the following note for the one now present on page 190 of "1956 Supplement to Book of ASTM Standards, Part 6," in D 1417-56T, Tests for Synthetic Rubber Latices:

"An alternate method for determination of total solids in synthetic rubber latices is described in D 1076-54T, Specifications and Methods of Test for Concentrated, Ammonia Preserved, Creamed and Centrifuged Natural Rubber Latex."

The task group on nomenclature was asked to recommend to the subcommittee at the June meeting a family letter designation for silicone rubbers and any further additions to D 1418-56T, Nomenclature for Synthetic Elastomers and Latices, decided upon by that time.

Subcommittee 13 recommended that in all ASTM publications the new synthetic nomenclature be used, particularly replacement of "GR-S" with "SBR." In addition, the subcommittee secretary was instructed to ask for the cooperation of government committees in the use of this new nomenclature.

The task groups on standard reference materials and code numbers for SBR were discharged with thanks since their assignments had been completed.

The proposed method of the chairman of subcommittee 13 of assigning new code numbers to new SBR production grades will be circulated for letter-ballot in the subcommittee after the incorporation of certain modifications suggested by subcommittee members.

Subcommittee 15—Life Tests. G. C. Maassen, R. T. Vanderbilt Co., chairman. The subcommittee voted to recommend that D 865-54T, Method of Heat Aging of Natural and Synthetic Rubber by the Test Tube Method, be advanced to standard. One change in paragraph 8(a) is to be made which will delete the 250-300° F. temperature range and substitute a reference to D 1349-54T, Recommended Practice for Standard Test Temperatures for Rubber and Rubber-Like Materials, for the recommended temperatures.

It was voted to retain D 1206-52T, Method of Test for Resistance to Aging of Vulcanized Rubber by Measurement of Creep, as tentative because of insufficient experience with this test method.

A tentative revision of D 518-44, Method of Test for Resistance to Light Checking and Cracking of Rubber Compounds, which will add a Method C for a tapered specimen, will be recommended after two additional minor changes.

No new information is available on a revised method for calibrating the light source under D 749-43T, Method of Calibrating a Light Source Used for Accelerating the Deterioration of Rubber. Work on this problem is continuing in Committee E-1 on Methods of Testing from which new data are expected in the near future.

A motion to sponsor a symposium on ozone aging of rubber for June, 1957, was defeated. A designated task group will further investigate the proper time for such a symposium and then solicit and review papers for such a program.

A task group was appointed to study ozone testing of rubber under dynamic conditions. A paper, which will survey the types of dynamic ozone testing methods now in use in the rubber industry, will be prepared by the chairman of this task group for presentation before Committee D-11 at the June meeting.

Subcommittee 17—Hardness, Set, and Creep. Sherman R. Doner, Raybestos-Manhattan, Inc., chairman. The chairman's comments to R. E. Hess at ASTM headquarters regarding the "Draft British Standard, Methods for the Determination of Compression Set — CW(RUC) 9215" were accepted by the subcommittee.

The micro-hardness tester of Testing Machines, Inc., and the report of R. E. Morris and J. M. Holloway, of the Mare Island Naval Shipyard, on this instrument were again discussed. Because of the limited interest in this hardness tester, further investigation will be deferred.

A letter-ballot will be circulated in the subcommittee to determine whether D 314-52T, Method of Test for Hardness of Rubber, should be advanced to standard.

The subcommittee has been asked to insert a paragraph in D 676-55T, Method of Test for Indentation of Rubber by Means of a Durometer, on the procedure for reporting results, and entitled "Report." Such instructions are in D 676-55T, but not under the "Report" heading. The subcommittee chairman will discuss this problem with Paul Smith, of ASTM headquarters staff, and be guided by his decision as to whether a paragraph headed "Report" should be included.

The problem of checking the A-2 Shore durometer for conformance to D 676-55T was discussed. It was decided that it was the instrument manufacturer's responsibility to see that any instrument conforms to the requirements of any accepted test method.

The task group assigned to conduct the round-robin test on hardness instruments has completed its work, but subcommittee

28 on statistical methods has not been able to complete its analysis of the results. The chairman of this task group was asked to circulate his report in its present form and to consider his assignment completed.

Subcommittee 20—Adhesion Tests. H. H. Irvin, Marbon Chemical Division, Borg-Warner Corp., chairman. Although D 429-55T, Methods of Test for Adhesion of Vulcanized Rubber To Metal, has been revised recently, some dissatisfaction is still evident with this method. In cases where the test results in a break in the rubber rather than at the rubber-to-metal bond, the only report possible is that the adhesion is greater than the recorded result.

Present efforts to improve further adhesion testing of rubber-to-metal products include investigations of the use of ultrasonic vibrations for determining bond quality, fatigue testing under dynamic conditions, and either modifying or supplementing D 429-55T, especially Method B, by introducing the aspect of elevated temperatures.

It was reported that testing by ultrasonic means has only advanced at present to the point of indicating bond or no bond. Dynamic fatigue testing does not seem to offer advantages over static methods.

In connection with testing at elevated temperatures it was suggested that time, temperature, and stress might be established as variables, and any two of these held constant while varying the other. This proposal will be summarized and presented for consideration by the subcommittee at its next meeting.

It was reported that no reply had been received from ISO/TC 45 regarding the latest comments to that committee by subcommittee 20 regarding D 429-55T revisions.

Representation from subcommittee 20 on Committee E-7 on Non-Destructive Testing was recommended to Committee D-11.

Subcommittee 21—Rubber Cements and Related Materials. J. F. Anderson, Goodrich, chairman. The subcommittee voted to ask Committee D-11 and ASTM headquarters to arrange for printing D 1084-55T, Methods of Test for Consistency, (under the jurisdiction of Committee D-14 on Adhesives), in the Committee D-11 manual. Such action will provide users of the D-11 manual with a needed alternate method of determining cement viscosity. The present D 553-42, Methods of Test for Viscosity and Total Solids of Rubber Cements, is no longer considered adequate.

An alternate method for the determination of total solids of rubber cements is also needed, and a procedure for a rapid test using the Cenco[2] moisture balance will be prepared and submitted to the subcommittee for consideration.

The subcommittee approved interchange of information between the chairman of subcommittee 21 of Committee D-11 and subcommittee 8 on bonded brake linings of the SAE Brake Committee in order to avoid duplication of effort in cement specification and test method work.

A bend test method for possible use in D 1205-53T, Methods of Testing Brake Lining and Other Friction Materials, will be circulated in the subcommittee for comments and approval or rejection.

The Chrysler block or disk shear test for friction materials bonded to metal will be recommended for inclusion in D 1205-53T after review by subcommittee 21 and Technical Committee A of SAE.

A request for clarification of D 903-49, Methods of Test for Peel or Stripping Strength of Adhesives from the Army Chemical Center will be forwarded to Committee D-14 which has jurisdiction over this method.

Subcommittee 23—Hard Rubber. W. F. Dermody, Stokes Molded Products, chairman. A revision of the hot-cold cyle test in D 639-52T, Method of Test for Asphalt Battery Containers, was recommended for letter-ballot in Committee D-11.

A proposed revision of the falling-weight impact test in D 530-55T, Method of Testing Hard Rubber Products, was defeated, and the revision was returned to the task group for further work. A method for a tensile impact test presented at a previous meeting of Committee D-20 on Plastics was submitted for consideration.

A proposed method of test for indentation hardness of hard rubber by means of a Shore Type D durometer was submitted for letter-ballot in Committee D-11 for acceptance as a tentative standard.

The subcommittee chairman reported on membership contacts, and three new members were welcomed to the subcommittee.

A task group was appointed to consider a specification system classifying available hard rubber materials.

Liaison with Committee D-20 in connection with revisions of D 530-55T on methods of test for tensile strength, flexural strength, Rockwell hardness, and durometer hardness, is planned.

A method for the determination of water absorption of hard rubber for inclusion in D 530-55T will be submitted for consideration of the subcommittee at the June, 1957, meeting.

Recommendations for the inclusion of standard test temperatures in D 1349-54T, in D 530-55T, and replacement of the present softening point determination in D 530-55T with the heat distortion test in D 648-56, were recommended for letter-ballot in Committee D-11.

Subcommittee 24—Coated Fabrics. K. L. Keene, United States Rubber Co., chairman. The subcommittee approved a change in the scope of the subcommittee to that of "rubber and rubber-like coated fabrics."

D 751-52T, Methods of Testing Rubber-Coated Fabrics, will be retained as a tentative standard, pending completion of interlaboratory tests now in progress.

Recommendations of the task group on the diaphragm burst test will be letter-balloted in the subcommittee.

Plans were formulated for interlaboratory tests on adhesion, cold flexibility, and tack tear tests.

Reports were made on the dead weight, Du Pont scrub tester, Gelbo tester, and the sandblast abrasion tester.

Subcommittee 25 — Low Temperature Tests. R. S. Havenhill, St. Joseph Lead Co., chairman. W. D. Brown, of Chrysler Corp., described a novel strain gage-oscilloscope method for determining the impact speed of the Scott solenoid brittleness tester.[3] It was shown that at an a.c. voltage of 94, the instrument would meet the velocity specification of 6.5 feet per second in D 746-55T, Method of Test for Brittleness Temperature of Plastics and Elastomers by Impact.

Rock Island Arsenal Report No. 57-100, entitled "Comparison of Three Dead-Load Admiralty-Type Rubber Hardness Testers," was distributed. It was shown that the MLI and the BS903 tester and the BS903 tester with double the major and minor loads had no significant reproducibility differences for nine different stocks run at temperatures of 73, —40, and —64° F. These data indicated the value of the higher loads for determining the hardness of extremely hard stocks at very low temperatures.

A task group was appointed to study the effect of built-in foot, separate foot, or no foot on the results obtained with these instruments. If the differences in results due to variations in the size of specimens can be resolved, the same hardness instrument can be used possibly in the ISO/TC 45 method for both room and low temperature tests.

It was recommended that owing to inaccuracies in the method and possible future changes in the temperature of the test, D 736-54T, Method of Test for Low-Temperature Brittleness of Rubber and Rubber-Like Materials, be retained as tentative.

A task group was appointed to review D 1053-54T, Method of Measuring Low-Temperature Stiffening of Rubber and Rubber-Like Materials by the Gehman Torsional Apparatus, and to suggest modifications to eliminate possible jaw-freezing and test chamber temperature variations, and to make the method more generally workable.

Addition of the following two sentences to D 1329-54T, Method of Evaluating Low-Temperature Characteristics of Rubber and Rubber-Like Materials by the Temperature-Retraction Procedure (TR Test), under the heading "Testing Elongation," paragraph 6, at the end of the paragraph, will be letter-balloted in the subcommittee:

"In such studies, crystallization of the long time conditioned specimens is indicated by the displacement of the TR curve toward the higher temperatures. Tests conducted at 50% elongation without previous long time conditioning have been found to correlate fairly well with stiffness tests."

This revision makes the present method more useful by adding an explanation of results obtained in studies using 50% elongation, which is already allowed in the present method.

It was decided to retain D 1349-54T, Recommended Practice for Standard Test Temperatures for Rubber and Rubber-Like Materials, as a tentative standard in view of the possibility that additional standard test temperatures may be added in the future.

Subcommittee 26 — Processibility. Rolla H. Taylor, Scott Testers, Inc., chairman. The task group appointed to develop a more stable rotor for use in the Mooney viscometer recommended in its report the

[2]Central Scientific Co., Chicago, Ill.
[3]Scott Testers, Inc., Providence, R. I.

use of a special 48 groove rotor as an alternate with the conventional rotor. The task group was instructed further, however, to obtain more data on the use of this 48 groove rotor with synthetic rubbers and for use in connection with the determination of cure characteristics.

The following additions and changes to Table 1 in D 927-55T, Method of Test for Viscosity of Rubber and Rubber-Like Materials by the Shearing Disk Viscometer, were recommended for letter-ballot in Committee D-11:

1. Under "Method of Preparation" add at the end of the first paragraph: "Measure the viscosity of standard rubber compounds, prepared in accordance with ASTM Method D 15, between two and four hours after mixing."

2. In the second paragraph, substitute "122 ±9° F." for "between 110 and 130° F."

3. For the last two sentences substitute "Prepare two specimens 1¾ inches in diameter from the thickest portion of the sheeted sample. Allow the massed rubber to rest at room temperature for at least 30 minutes before measuring its viscosity."

Subcommittee 29 — Compounding Ingredients. A. E. Juve, B. F. Goodrich Co. Research Center, chairman. Negative votes from the subcommittee letter ballot on a proposed revision of D 15-55T, Methods of Sample Preparation for Physical Testing of Rubber Products, which has as its purpose incorporation of formulations and mixing procedures for synthetic rubbers and other modifications, actually include only two controversial points. These points were the formula for testing SBR 1502 and the proposed method of conditioning the carbon black.

A task group was appointed to provide a satisfactory wording as a footnote to Table 2 which would remove these two objections, after which the D 15-55T revision will be submitted to Committee D-11 for letter ballot.

It was announced that the National Bureau of Standards is now able to seek bids immediately for the preparation of a standard lot of natural rubber.

A task group report recommended that refining of carbon black stocks following mixing was not necessary.

A rough draft of a proposed method for evaluating carbon blacks was discussed in an attempt to reconcile conflicting views on various points. Also, the question of incorporating the carbon black procedure in D 15-55T or preparing a separate method was discussed. The subcommittee chairman will rewrite the proposed method to include the modifications agreed upon, and a copy will be forwarded to R. D. Stiehler at the National Bureau of Standards. Dr. Stiehler will attempt to incorporate it in a trial draft of a combined method for consideration by the subcommittee.

Flett Honored by AIC

Lawrence H. Flett, since 1945 director of the new products division of National Aniline Division, Allied Chemical & Dye Corp., New York, N. Y., was granted honorary membership in the American Institute of Chemists at a dinner-meeting of the organization on March 11 at the Hotel Commodore, New York, N. Y. He addressed the group on "Pursuit of Invention."

Mr. Flett has been associated with National Aniline for 35 years. He has been granted more than 75 United States patents, is the author of many scientific papers, and the co-author of several books. He was president of the AIC between 1948 and 1952.

Detroit Hears Sweitzer on Carbon Black in Polymers

Carl W. Sweitzer, Columbian Carbon Co., spoke to 140 members of the Detroit Rubber & Plastics Group at the Detroit Leland Hotel, Detroit, Mich., February 1, on the subject of "Carbon Black—Polymer Interactions." Llewellyn Heard, Standard Oil of Indiana, gave an after-dinner talk on "Fire Magic."

Dr. Sweitzer said that a mounting body of work indicates that free radicals from rubber add to the carbon black surface during mastication and that this action is responsible, at least in part, for the reinforcing action of carbon black.

Application of this principle has been made in improving the performance of butyl rubber-carbon black mixes on a commercial scale. Additional use has been made in the laboratory in compounding silicone rubbers. The successful use of carbon black as a filler for unsaturated polyester resins has also been achieved.

The increase in hot tensile strength of carbon black-filled polyethylene after irradiation treatment appears to be another example of reinforcement through the addition of radicals to the carbon black surface, according to Columbian's director of research and development.

He said the action of carbon black in preventing oxidative degradation of polyethylene, polyvinyl chloride, and unvulcanized rubbers is undoubtedly due to free radical interaction in addition to the well-known light-screening action of carbon.

Dr. Heard provided a diverting demonstration of the basic principles of catalysis and reaction rates.

AIEE Schedules Confab on Rubber, Plastics Industries

The ninth conference on electrical engineering problems in the rubber and plastics industries will be held April 8 and 9 at the Mayflower Hotel, Akron, O., by the Rubber & Plastics Industries Subcommittee of the General Industry Applications Committee of the American Institute of Electrical Engineers.

The two-day conference will begin with a keynote address by Dan Pellett, The B. F. Goodrich Co. M. F. Giggliotte, Monsanto Chemical Co., will speak on "Plastics as an Engineering Material of Construction" during a banquet on April 8.

Other technical papers to be presented are the following: "Adjustable Speed Drives—Electrical, Hydraulic and Mechanical—Their Application to Rubber Processing Equipment," Wilbur Jones, The Goodyear Tire & Rubber Co., "Electric Motor Braking Methods for Rubber and Plastics Industries," John C. Ponstingl, Westinghouse Electric Corp.

Also "Design Features of Electrical Installations for Areas Which Are Hazardous Because of Flammable Vapors and Combustible Dusts," C. M. Park, Mill Mutual Fire Prevention Bureau; "Electrical Safety Standards," P. T. Powell, United States Rubber Co.; "Aluminum Conductors," R. R. Cope, Aluminum Co. of America; "Programming," L. F. Lewis, General Electric Co.; and "Special Drive for Rapid and Accurate Cycling," Tom Jones, National Rubber Machinery Co.

Subcommittee reports on "Problems Due to Atomospheric Contamination" and "Standardization for Rubber and Plastics Industries" will be presented as the last item on the two-day agenda under the chairmanships of E. L. Smith and W. S. Watkins, respectively.

Tlargi Hears Lorenz on Silicone Rubber Advances

"History and Utilization of the New Properties Available in Silicone Rubber" was the subject of a talk given by J. H. Lorenz, director of technical service, silicones division, Union Carbide & Carbon Corp., New York, N. Y., before 300 members of The Los Angeles Rubber Group, Inc., at the Hotel Biltmore, Los Angeles, Calif., February 5.

Marked improvements in silicone rubber gum stocks and compounds over the past two years have widened the utility of silicones, Mr. Lorenz noted. The advent of vinyl-containing gum stocks allows the use of carbon black and reactive fillers, as well as the conventional silica fillers. Curing the vinyl gums can be accomplished by benzoyl peroxide, 2,4 dichloro benzoyl peroxide, or X-1960 ditertiary butyl peroxide curing compound.

Newer properties available were listed by Mr. Lorenz as 600° F. service, steam service, resistance to reversion, conductive properties, and bonding of silicone rubber to metals and fabrics. These new properties have found utilization in such fields as silicone rubber-covered rolls, hot air ducting, and shielding of electronic equipment.

Other new properties were said to be included in reversion resistant compounds, direct feeding, premium-grade extrusion compounds, and cable fillers and sealants that will not extrude or drip.

Further modification of the basic polymer, leading to better tensiles, tears, and solvent resistance, is under way, Mr. Lorenz concluded.

After-dinner entertainment at the meeting consisted of a demonstration of hypnotism by Edwin L. Baron, originator of the "Reduce by Hypnotism" technique.

Southern Rubber Group Panel Discussion— "Elastomers for Specific Applications"

The program for the meeting of the Southern Rubber Group held in New Orleans, La., November 16 and 17, 1956, included two panel discussions: one entitled "Compound Design" was published in our February issue. The second panel discussion on the subject of "Elastomers for Specific Applications" has been edited and is presented herewith.

The moderator for the discussion on elastomers was M. E. Samuels, of Copolymer Rubber & Chemical Corp. Members of this panel were J. L. Ernst, Enjay Co., Inc.; F. J. Honn, M. W. Kellogg Co.; E. H. Rothermel, Dayton Rubber Co.; L. R. Mayo, E. I. du Pont de Nemours & Co., Inc.; W. J. Boyd, Xylos Rubber Co.; F. J. Sackfield, American Synthetic Rubber Corp.; J. F. Svetlik, Phillips Chemical Co.; and T. D. Talcott, Dow Corning Corp. The moderator and the panelists for this second panel discussion are shown in the photo on page 891.

Other details of this initial meeting and organization of the new Southern Rubber Group were presented in our December, 1956, issue, page 442.

Butyl Rubber

By J. L. Ernst

Enjay Co., Inc., Linden, N. J.

SINCE the first commercial production of butyl rubber in 1942, it has received increasing recognition as a versatile low-cost synthetic elastomer. Butyl-type polymers are now produced in two plants in the United States. A third plant is operated by the Polymer Corp. in Canada. The combined capacity of these three plants is more than 116,000 long tons per year. In addition, two other plants are under consideration in the United States, and one in France, which would raise the world capacity to 175,000 long tons of butyl rubber annually.

Butyl rubber is a high molecular weight copolymer made up of 97 to 99½% isobutylene, and 0.5 to 3% isoprene. The resultant polymer possesses the structure shown in Figure 1. This structure is quite different from those of natural rubber (polyisoprene) and the styrene-butadiene copolymers formerly known as GR-S.[1] In addition to the basic chemical structure and unsaturation differences, butyl rubber is a long straight-chain polymer with essentially no cross-linking; while the more highly unsaturated polymers are cross-linked between chains to a varying degree. Butyl rubber can be mixed, compounded, and processed in a manner similar to natural rubber, except that more vigorous vulcanizing agents are required.

The process for making butyl rubber is carried out at —140° F. with the polymer appearing as a slurry in a non-freezing solvent rather than as a latex, as is the case with SBR. There are two main (controllable) variables, molecular weight and unsaturation, which determine the grade of polymer. The presently available grades are listed in Table 1.

Butyl rubber can be used in the fabrication of many rubber products and is low in cost. It is therefore, considered a general-purpose elastomer. When properly compounded, moreover, butyl rubber possesses a number of inherent advantages over natural rubber and styrene-butadiene copolymers without additional cost. The most important of these are as follows: (1) abrasion resistance; (2) impermeability to gases; (3) tear resistance; (4) heat and age resistance; (5) ozone and weather resistance; (6) chemical and solvent resistance; (7) flex resistance; (8) high electrical resistivity and dielectric strength.

The superior performance characteristics of butyl vulcanizates are governed in a large measure by the chemical structure of the parent polymer, its low and controlled unsaturation level, and a closely packed linear chain. Compounding techniques, however, can do much to enhance further the properties of the vulcanizate. In most cases the techniques to be used are dictated by a combination of economics, the mechanical properties desired, and the enviromental conditions to be met. A critical selection of the ingredients necessary for vulcanization, reinforcement, plasticization, and processability has, in many cases, permitted the successful use of butyl in applications previously filled by other polymers, and with a marked improvement in certain desirable properties.

Butyl rubber has long been used for inner tubes, curing bladders, and high-voltage cable. Today it is finding wide application in new fields. For example, proofed goods and automotive window channeling are being made from butyl rubber because of its excellent weatherability. Automotive bumpers and sponge

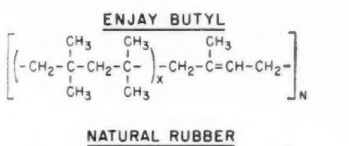


Fig. 1

make use of its excellent damping and shock absorption qualities. Hot materials belting, washing machine parts, radiator hose, spark plug nipples, and many other articles requiring a high degree of heat resistance are now made from butyl rubber. These are only a few of the places that butyl is going today. A complete listing would require more time than is available.

In closing, I would like to mention that the development of an all-butyl tire is actively being pursued.[2] These tires have shown excellent durability, reduced noise level, freedom from squeal during cornering, and freedom from chipping, cut growth, and sidewall cracking.

There have been many recent developments in butyl compounding, and we have seen modified polymers, such as brominated butyl, produced. In the next few years we may expect to see even more polymer modifications, new accelerators, fillers, and compounding techniques.[3]

Questions and Answers

Q. What is relative scorchiness of brominated butyl vs. regular butyl rubber?

A. Brominated butyl, because of its faster cure rate, is considerably more scorchy than regular butyl rubber. Effective retarders, such as magnesium oxide and sodium acetate, however, are available.

Q. Is brominated butyl better than regular butyl for Bag-O-Matic[4] bladders?

A. I don't know that a complete study has been made of this application because the economics are not too favorable. Based on heat aging data of a number of stocks, I would expect that regular butyl would outlast the brominated butyl rubber in

[1] Now designated SBR. American Society for Testing Materials, Philadelphia, Pa., ASTM D 1418-56T.
[2] RUBBER WORLD, Oct., 1956, p. 103.
[3] *Ibid.*, Dec., 1956, p. 413.
[4] McNeil Machine & Engineering Co. trade mark.

TABLE 1. ENJAY BUTYL

Grades		Mooney Plasticity	Ozone Resistance	Heat Resistance	Cure Rate
Regular	Non-Staining		Excellent	Good	Slow
035		35-47	↑	↓	↓
150*	165	41-49			
215	265	41-49			
217	267	60-70			
218	268	70-			
325	365	41-49	Good	Excellent	Fast

*Also available in coated cartons. Standard package polymer is film wrapped.



Moderator and panelists for "Elastomers for Specific Applications" panel discussion

such bladders. Combinations of these two elastomers may offer possibilities also.

Q. What can be done to improve the flex cracking and retard the growth of a butyl bladder?

A. This is actually two questions, since flex cracking is not generally associated with bladder growth. Although butyl rubber is considered to have excellent resistance to flex cracking, poor dispersion, especially of the zinc oxide and the curatives, will impair this property. To insure good dispersion of the zinc oxide, used in amounts of about 25 phr, it should be added early in the mix and preferably added with the fillers to prevent caking on the Banbury mixer rotors. The accelerators, either GMF[5] or Dibenzo GMF,[5] are available as clay or resin dispersions which are preferred over the 100% material when dispersion is a problem. Contamination of butyl with other rubbers, as distinguished from intentional addition, can also cause flex cracking, and proper segregation procedures for rubbers in the mill room should be followed.

Bladder growth is generally a result of a low state of cure, and, therefore, unsaturated oils and resins, as well as high concentrations of retarders, should be avoided in the bladder compound.

Q. Please discuss the relative merits of small amounts, up to 10 parts, of natural or synthetic rubber in butyl Bag-O-Matic bladder stocks.

A. Although butyl and natural rubber or SBR are basically incompatible, there are certain applications where such blends appear desirable. One of these applications is Bag-O-Matic bladders.

The merits of a butyl/SBR blend for this application lie in the fact that upon extended heat aging, stocks containing SBR become slightly harder, whereas those without SBR become softer. The advantage of butyl/SBR blends in bladder stocks are outstanding when a high level of sulfur is present, such as would be built up on the surface of the bladder. Five parts of SBR appear optimum; higher concentrations, 10 phr, raise the hardness appreciably and do not contribute to heat resistance. The SBR should be well dispersed in the butyl rubber, and a red lead or lead oxide cure is required.

[5]Naugatuck Chemical Division, United States Rubber Co., trade marks. GMF is p-quinone dioxime; Dibenzo GMF is p,p′ dibenzoyl quinone dioxime.

[6]Kel-F is M. W. Kellogg Co. trade mark.

Kel-F[6] Elastomers

By F. J. Honn

M. W. Kellogg Co., Jersey City, N. J.

KEL-F Elastomers 5500 and 3700 are fully saturated copolymers of chlorotrifluoroethylene (CF_2=$CFCl$) and vinylidene fluoride (CF_2=CH_2) noted for their extreme thermal stability and outstanding resistance to fuels, oils, and corrosive chemicals.

These elastomers are products of an intensive research program on fluorocarbon polymers. Until recently, fluorocarbon polymers were thought to be inherently plastic rather than elastomeric. But three general methods have now been discovered for synthesizing elastomers containing a high proportion of fluorine: (1) copolymerization of hydrocarbon dienes (butadiene) with fluoro-olefins (CF_2=CF_2, CF_2=$CFCl$); (2) polymerization of partially fluorinated butadienes (CF_2=CH=CF=CH_2); and (3) copolymerization of fluoroolefins to produce saturated polymer chains containing enough hydrogen to provide flexibility, but not enough to destroy the heat and chemical resistance characteristic of fluorine polymers.

Kel-F Elastomers 5500 and 3700 are examples of the third class. The high proportion of fluorine (>50%) in these polymers makes them thermally stable for long periods up to 400° F. and for short periods up to 480° F. Fluorine also shields these elastomers from attack by strong acids, alkalies, oxidants, alcohols, aliphatic solvents, aromatic fuels, chlorinated solvents, hydraulic fluids, silicone oils, and sulfur-bearing extreme-pressure lubricants. The elastomers, especially grade 5500, will withstand prolonged immersion in red and white fuming nitric acid under conditions where other rubbers disintegrate within a few minutes or even seconds. For applications demanding maximum resistance to attack and penetration by RFNA, a compatible resinous copolymer of CF_2=$CFCl$/CF_2=CH_2 is available as Kel-F 800 resin.

The electrical properties of elastomer grades 5500 and 3700 are similar to those of vinyl resins. An outstanding advantage of these elastomers is their low water absorption and excellent retention of electrical properties at high humidity.

In addition to their heat resistance, these elastomers have a low brittle point (about —60° F.). The polymers stiffen at a somewhat higher temperature (0° F.), but not enough to interfere with many applications.

Excellent oxygen, ozone, and weathering resistance are a further consequence of the high fluorine content of the Kel-F Elastomers. The polymers do not support combustion, nor are they attacked by micro-organisms. The white color of the gum makes possible a wide selection of colors.

Grades 5500 and 3700 are available as compressed bales of raw gum rubber. Kel-F Resin 800 is available as a free-flowing white powder. The elastomers are also available as high solids latices (60%), as is Kel-F Resin 820, a high molecular weight version of 800 resin.

The Kel-F Elastomers are vulcanizable in the same sense as natural or other synthetic rubbers. Extensive research has been required, however, to find curatives which react with the relatively inert Kel-F Elastomer structure. In the polymer unit, there are two likely sites for such a reaction—chlorine and hydrogen:

$$=CF_2=CFC1=CH_2=CF_2=$$

Practical vulcanization recipes have now been developed based on polyamines and organic peroxides. In both cases, metal oxides are incorporated as accelerators. The most satisfactory amine curatives are primary aliphatic amines such as hexamethylene diamine (HMDA). To prevent scorch, HMDA is added to Kel-F Elastomer as an inner salt of HMDA-Carbamate. The most satisfactory peroxide is benzoyl peroxide. Amine cures are preferred for oil resistance, peroxide cures for oxidant resistance and minimum water absorption.

Kel-F Elastomer vulcanizates develop high tensile strength without the addition of fillers. Where greater hardness or modulus is required, silicas may be added up to 20 phr. Kel-F Elastomer compounds are mixed and processed on standard rubber machinery.

Applications for these elastomers are being found in the aircraft, chemical and electrical industries where a *heat* resistant, *chemical* resistant rubber is required. Gaskets, diaphragms, O-rings, seals, hose, tubing, cable jackets are a few examples of the many applications under study.

Questions and Answers

Q. Describe the compounding of Kel-F and value of cured Kel-F compounds compared to other available elastomers with respect to oil resistance.

A. For oil resistance, amine cured Kel-F Elastomer 3700 is normally recommended. Comparative data for this elastomer and other rubbers in oils are incomplete and therefore somewhat inconclusive. Generally speaking, these data do show that in many oils Kel-F Elastomer offers no great advantage over more conventional, oil-resistant elastomers at service temperatures up to 300° F. At temperatures of 300-400° F., however, the greater thermal stability of Kel-F Elastomer, coupled with its oil resistance, comes into play, and the use of this elastomer is being considered in many such applications. One manufacturer of automotive seals has found that Kel-F Elastomer seals will outrun those of any other material in transmission fluids at temperatures of 300-400° F.

The following data (Table 1), obtained by a Wright Air Development Center contractor, compare the properties of Kel-F Elastomer with a Hycar 1001[7] stock after immersion in aircraft fuels.

Q. Can Kel-F Elastomer compounds be formulated which are suitable for use in RFNA and JP-4 fuel at temperatures from +160 to −65° F., and ambient air temperatures of +300 to −65° F?

A. The data provided with the answer to the preceding question indicate the resistance of Kel-F Elastomer to JP-4 at temperatures up to 400° F. Functional tests on RFNA compounds up to 250° F. show that this elastomer is the most resistant elastomeric material available. However, the very lowest temperature at which Kel-F Elastomer parts have been used dynamically with success was −40° F.

Q. We have had difficulty in obtaining elastomers which are suitable for dynamic and static seals in diester lubricants (MIL-L-7808)[8] and silicate ester hydraulic fluids (Oronite[9] 8515) at temperatures up to 400° F. and yet be flexible at −65° F. Has any of the panel members knowledge of such a compound? If so, who is the manufacturer and what is his designation?

A. None of the known elastomers is satisfactory for exposure to MIL-L-7808 or Oronite 8515 over the stated temperature range.

Q. Kel-F Elastomers have excellent resistance to strong oxidizing acids. However, all recommended adhesives for these elastomers are those which will be readily attacked by acids. Are there any new adhesives for Kel-F Elastomers with equal chemical resistance?

A. All the useful adhesives for Kel-F Elastomer, at present, are based upon epoxy resins. Work continues, but no acid-resistant adhesives for Kel-F Elastomer are available.

[7]B. F. Goodrich Chemical Co. trade mark.
[8]Defense Department Specification.
[9]Shell Chemical Co. trade mark.
Oronite 8515 Composition:
15%—Di-2-ethyl hexyl sebacate
79%—Hexa (2-ethyl-butoxy) disiloxane
4%—Methyl ethyl silicone fluid XF 371
2%—Para-para' dioctyl diphenylamine
.02%—Quinizarin.
[10]Type Descriptions and Packing Specifications for Natural Rubber. July 1, 1952. The Rubber Manufacturers Association, Inc., 444 Madison Ave., New York, N. Y.

TABLE 1. SUMMARY OF THE ORIGINAL AND AGED PROPERTIES OF THE MOST PROMISING COMPOUNDS TESTED TO DATE

Final Minimum Properties Desired:	Tensile strength, psi.	500
	Elongation, %	100
	Shore A hardness	50-90
	Volume change, %	−2 to +40
	180° Bend test	pass

Physical Properties	Original Properties	Physical Properties after 500 Hours' Immersion at 250° F. JP-4*	JP-5*	70/30†	325° F. JP-4	JP5	70/30	400° F. JP-4	JP-5	70/30
Kel-F Elastomer 5500, Peroxide Cured										
Tensile strength, psi.	2850	1180	1610	600	1090	1070	failed	550	710	not tested
Elongation, %	435	390	420	390	490	500	.....	550	500	not tested
Shore A hardness	83	69	68	61	73	74	.....	46	63	.....
Volume change, %	.....	+15.0	+11.8	+37.7	+21.0	+16.8	.....	+34.4	+24.9	.....
180° bend	.....	pass	.....		pass	.....		pass	.....	
Hycar 1001 Compound										
Tensile strength, psi.	1700	1660	1735	950	1850	2035	1280	.....	failed	.....
Elongation, %	370	230	265	225	180	205	175			
Shore A hardness	78	77	77	63	74	74	62			
Volume change, %	.....	+9.1	+9.3	+21.8	+8.8	+12.6	+24.0			
180° bend	.....	pass	.....		pass	.....				

Even better Kel-F Elastomer performance is expected from 3700 amine compounds.

*Petroleum aircraft fuel, Defense Department Specification.
†Isooctane-toluene test fluid.

Natural and Reclaimed Rubbers

By E. M. Rothermel

Dayton Rubber Co., Waynesville, N. C.

I HAVE been asked to discuss natural rubber and reclaimed rubber for some five to ten minutes. All present here today, fully realize that only the high spots can be mentioned in that length of time. For this reason I have decided to make a few remarks about the preparation and uses of natural rubber. These facts may already be familiar to most of you, but some may have been forgotten in our present emphasis on synthetic polymers. These facts have been collected from already published sources and from personal experience.

Natural Rubber

Natural rubber plantations have some 70 to 80 trees per acre, and each tree yields some three to eight pounds or more of dry rubber per year. This yield, however, is affected by tree age, soil conservation, cover crops, tree diseases, budgrafting, and other biological and botanical factors.

Smoked sheets are produced by coagulating latex, previously diluted to about 15% solids, in partitioned pans using acetic or formic acid. This operation consumes some 16 to 20 hours. The pieces of coagulum, each of which will become a separate sheet, are then floated in water troughs through a series of even-speed rolls, the last of which is embossed to give the familiar design to the sheets.

The sheets are then further washed and hung up to dry. They go next to the smoke house, which is not much more than a 110 to 130° F. drying oven, through which the smoke is allowed to pass. The sheets are left in the smoke house some 5-12 days. The phenolic content of the smoke retards mold formation and spoilage. The sheets are then inspected, graded, and baled.

The Rubber Manufacturers Association[10] recognizes six different grades of smoked sheets, depending upon color, cleanliness, appearance, and packaging. The usual package contains five cubic feet.

Pale crepe is prepared similarly to smoked sheets except that sodium bisulfite is added to the latex, before coagulating, to bleach the non-rubber portions. The coagulum is then passed through uneven-roll-speed wash mills with progressively closer roll openings. It is further washed and hung to dry in sheds at 90 to 110° F. prior to packaging. Higher temperatures have a tendency to slightly discolor crepe.

The RMA[10] also recognizes eight grades of pale crepe, four thin, and four thick. Thick crepe is made by passing several thinner sheets simultaneously through a wash mill, whose rolls have been previously set at desired openings.

Many lower or "off grades" of natural rubber are marketed such as flat bark, amber crepe, skin crepe, estate brown, blanket crepe, rolled brown, and others. These are all very useful grades and can very economically be used by proper compounding and by consideration of the end-product. In fact, the marketing of these off grades often means the difference between a profit and a loss for the natural rubber producer. Many of these grades

have been coagulated naturally and, if clean, are excellent. This natural coagulation does something to improve cure rate and physical properties of the vulcanizates.

Prior to World War II no effort had ever been made by growers to classify or produce natural rubber with uniform physical properties. As a result, physical properties could vary from bale to bale or within the same bale. Since that time, however, some attempt has been made to classify natural rubber with respect to rate of cure. Competition of synthetic rubber perhaps has been a factor in bringing this about. Limited amounts of smoked sheets are now supplied as Technically Classified Rubber in fast-, medium-, and slow-curing grades, designated by blue, yellow, or red circles painted on the bale.

Since it is desirable to know something about the physical properties of the rubber being used, the Division of Rubber Chemistry of the American Chemical Society in 1936 recommended a series of formulae to be used in testing crude natural rubber. One of these formulae will evaluate the characteristics of a rubber sample and indicate any deficiency of fatty acid. Some rubbers, especially wild rubbers, are deficient in fatty acids, however, and will not develop their best properties unless sufficient fatty acid is present.

In order to evaluate rubbers of this type the Crude Rubber Committee of the Division of Rubber Chemistry has other recommended formulae. Full details on these formulae are available upon request, directed to the secretary of the Division.[11]

In view of the inherent variations in the physical properties of any grade of natural rubber, as received on the market, one of the most important steps for a user to take is that of blending various shipments of each grade before further processing. The small user may have some trouble doing this, but with a little ingenuity it can be worked out.

To the best of my knowledge natural rubber has yet to be surpassed for many items. This point is true in the case of vibration dampeners; some colored products and drug sundries; products requiring very high resilience, and products flexed under constant elongation. In addition, natural rubber provides the best cut-growth resistance in truck and bus tire treads, excellent hot tear, and low heat buildup. The rubber compounder will find the hysteresis properties of properly compounded natural rubber difficult to equal when compared to any of the synthetic polymers.

Reclaimed Rubber

My few words here, in connection with reclaimed rubber, are not meant to be based upon actual experience in commercial reclaiming since I have had none. Furthermore, I will not try to describe the various methods of reclaiming or to outline methods of scrap collection. I feel we all have, at one time or another, attempted to work up trimmings, factory scrap, and scorched stocks into reusable materials, and this is where my actual knowledge ends. I recommend that all of you interested in reclaimed rubber carefully read the report of a symposium sponsored by the Connecticut Rubber Group.[12] In this report, experts from six of the major reclaiming companies have given answers to specific questions. In addition to this, very good lectures have been given to the Philadelphia, Detroit, Chicago, and other rubber groups by experienced reclaimers. These are available, from the authors, for personal study and review.

Reclaimed rubber, I think, can be defined as a depolymerized or regenerated and plasticized product, resulting from the introduction of heat energy, mechanical energy, and chemical action to scrap or discarded vulcanized rubber. This resulting product can, in addition, be classified as a partially compounded rubber stock, since much of the zinc oxide, antioxidants, and other original materials go through the various reclaiming processes virtually unchanged. Consequently, reclaimed rubber can be used alone or in combination with virgin polymers.

The question arises, just what are the advantages of reclaimed rubber? I shall attempt to list the major reasons for using reclaimed rubber without going into lengthy details or necessarily listing them in order of importance.

1. Reclaimed rubber stabilizes stock plasticities inasmuch as it is not affected excessively by remilling or reprocessing.
2. Reclaimed rubber extrudes and calenders faster than stock mixed from all new rubbers. The gage of extruded stocks containing reclaimed rubber can usually be maintained to closer tolerances than that of stocks without reclaim.
3. Reclaimed rubber permits faster mixing cycles. Reclaim is ready-made to absorb additional compounding ingredients, and lower power consumption and lower labor costs follow.
4. Reclaimed rubber is less thermoplastic; consequently products made with reclaim are less subject to sag and deform in open steam cures.
5. Reclaimed rubber reduces shrinkage in die cut blanks.
6. Stocks containing reclaimed rubber generally cure faster than when all new rubber is used. In addition, thick or heavy moldings appear to cure more uniformly.
7. Certain stocks containing reclaimed rubber age better than if all new rubber were used. This point is particularly true of friction or adhesive tapes.
8. Modern reclaimed rubbers can be had with a good portion of the various necessary compounding ingredients already added. This advantage is a particular one to small operators.
9. Reclaimed rubber reduces or maintains material costs. Between 1932 and 1955, No. 1 Smoked Sheets varied from 3-4¢ per pound to 74¢ per pound. During this same period first-line whole tire reclaim varied only from 4.1¢ per pound to 10.5¢ per pound.

In conclusion, we may state that the reclaiming of rubber involves the grinding of waste rubber articles, the removal of fibrous or metallic material if present, and the conversion of the rubber to a plastic condition with the aid of heat, reclaiming agents, and catalysts. The resulting rubber is processed and finished with or without added compounding ingredients or modifiers to develop specific properties.

Manufacturers of reclaimed rubber produce more than 200 types and grades of product, prepared to specifications, which provide desired qualities for specific uses in manufactured products. The reclaim may be prepared in sheets, slabs, blocks, pellets, or powder.

The economical and technological advantages are clearly defined. Historically the United States consumption of reclaim rubber, in tonnage, is approximately one-fifth of the total consumption of all new rubber, natural and synthetic combined. This fact illustrates the relative stature and importance of the rubber reclaiming industry. Producers of this commodity contribute to the conservation of our natural resources as waste rubber products are converted to a material of great importance to our normal economy. The strategic value of reclaimed rubber in times of national emergency is immeasurable. It is, essentially, a primary contribution to our rubber supply.

Questions and Answers

Q. What type of tests data characterizing raw polymers is most helpful to the compounder? For example, is that now supplied by SBR copolymer plants useful, or how could it be made more useful?

A. To the compounder for SBR it is thought that cure data, oil and pigment content, if present, and viscosity are most helpful. This type of information should not be changed or reported in a less comprehensive nature. Other properties usually reported, I feel, are of more importance to a purchasing agent or director of development and are of secondary importance to the average compounder. Actually, information helpful to one user may be of little value to another. The answer to this question depends upon individual circumstances.

Q. What happens when natural rubber is blended with various synthetic rubbers? Are the resulting properties necessarily directly proportional to the combination used?

A. This question is quite involved inasmuch as there are many synthetic rubbers with which natural rubber can be blended. Strictly speaking, the answer to the second part of this question is no. Very often such blending is done to obtain special properties in the finished product or to obtain particular processing properties.

The following is a short résumé of what can be expected when natural rubber is blended with the various synthetics.

NATURAL AND NITRILE RUBBERS. The blending of nitrile type rubbers with natural rubber is not commonly done in view of the fact that these two materials are not considered entirely compatible.

[11] A. M. Neal, E. I. du Pont de Nemours & Co., Inc., elastomers department, Wilmington, Del. (Subcommittee 12 of Committee D-11 on Rubber of the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa., took over Rubber Division, ACS, Crude Rubber Committee work in 1950. EDITOR.)

[12] RUBBER WORLD, Aug., 1956, p. 730; *Rubber Age (N. Y.)*, Aug., 1956, p. 796.

As Mr. Boyd explains, one of the most common products manufactured from a blend of these rubbers is milking-machine inflation parts. The ratios used result in satisfactory oil and fat resistance and at the same time improve hot tear, snap, and resilience as compared to an all-nitrile stock. In this blend the plasticizers should be compatible with both rubbers, and the rubbers should be very thoroughly blended to bring out the best reproducible physicals.

For this and other reasons it is difficult to say that all of the resulting properties are necessarily directly proportional to the ratio of rubber used. It can be said, however, that oil resistance comes close to being directly proportional.

NATURAL AND NEOPRENE. In this connection, as with all other specialty polymers, very little extensive data have ever been published pertaining to natural rubber blends. Most of this type of work has been done by the individual processors to arrive at end-products meeting his particular needs.

The following facts are, however, thought to be true as far as natural rubber/neoprene blends are concerned.

1. Forty to 50% neoprene is required with natural rubber to show any marked improvement in outdoor exposure properties of the blend. Blends with percentages of neoprene higher than this amount are characterized by more pronounced neoprene properties. The same can be said of blends of Hypalon[13] and natural rubber with respect to ozone resistance.

2. The properties of different blends of neoprene and natural rubber, between 20-80 and 80-20 ratios, closely follow a straight line with respect to oil swell, flex resistance, air permeability, hardness, tensile strength, and elongation. As in other instances, these properties are subject to the further effects of the degree of filler loading, plasticizer content, and modifying agents present.

3. Small amounts, up to 10%, of natural rubber in Neoprene Type G show a marked improvement in tear resistance at room or at elevated temperatures. Larger amounts do not improve this property.

4. Ten to 30 parts of natural rubber lower the brittle point of neoprene compounds. Here again, this application is a special one inasmuch as increased amounts of natural rubber affects oil swell, and the advantages of neoprene are diminished, if not completely lost.

NATURAL AND THIOKOL[14] POLYSULFIDE RUBBERS. Blends of these two materials have been used in an effort to obtain desired resistance to swelling in mixed solvents containing ketones, aromatics, and esters. It has been said that the resultant product possesses the desired properties; however, factory processing difficulties make such a blend impractical.

Natural rubber is used to impart building tack to polysulfide rubbers. In amounts above 10% the solvent resistance decreases at a much faster rate than what would be expected from the behavior of the materials separately.

[13] Du Pont trade mark. Chlorosulfonated polyethylene.
[14] Thiokol Chemical Corp. trade mark.

NATURAL AND SBR. Our experience indicates that natural and SBR stocks, of similar original physical and cure properties, can be blended in nearly all proportions, with little or no variation of original properties, from the resulting blends.

When the two stocks have different physicals, the resultant compound does not always possess average or mean properties. For example, 50/50 blends usually have tear properties more like those of a natural rubber stock. Furthermore, our experience indicates that the aging and flexing properties more nearly resemble the polymer in the majority than what might be normally expected.

Various compounding materials including accelerators, plasticizers, sulfur, and reinforcing agent have perhaps as much of an effect upon the final properties of blends of natural rubber and SBR as do the two rubbers themselves.

Neoprene and Hypalon

By L. R. Mayo

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

NEOPRENE is one of the oldest of the synthetic rubbers, having been first produced on a commercial scale in the early 1930's. It is manufactured by the emulsion polymerization of chloroprene (2 chloro-1:3 butadiene) obtained from the reaction of hydrogen chloride and monovinyl acetylene; the latter is prepared directly from acetylene. The structure of neoprene bears a close resemblance to that of natural rubber. The basic unit is a four-carbon group with one double-bond and a chlorine attached to one of the double-bond carbons in the same position as the methyl group in the natural rubber polymer. Naturally, the presence of this chlorine is of greatest importance in determining the characteristic properties of neoprene.

Although when it was first introduced, neoprene was hailed as an oil-resistant rubber, there certainly would be very little sold today if this point were its only claim to fame. A rubber compounder usually selects neoprene not for a single specific property—many of which can be equalled or excelled by another material—but for a balance of values, all of which contribute to eventual product performance.

Supporting this idea, I'd like to run through some of the important reference points by which rubbers, in general, are evaluated and point out where neoprene fits into this picture.

Heat Resistance

Aged in air at elevated temperatures, neoprene stocks are generally superior to other general-purpose rubbers, but inferior to those synthetics which have been designed primarily for heat resistance. These stocks may be aged up to 3-4 days at 300° F. and still retain some degree of workable flexibility. If air is excluded —as in a part operating in oil—or if access of oxygen to the neoprene surface is restricted—as in a gasket or seal—service life at high temperatures is dramatically extended.

Low-Temperature Properties

The low-temperature properties of neoprene are inferior to those of SBR and natural rubber, but it is possible to compound for functional flexibility as low as —60° F. and brittle points down to —90° F. without seriously compromising other values.

Oil Resistance

The oil and fuel resistance of neoprene, as judged by total immersion swelling tests, is not outstanding in comparison with those synthetics containing acrylonitrile. A combination of high retention of strength in the swollen condition and greatly reduced volume change observed when only one surface is in contact with the fluid, however, permits the successful use of neoprene in applications which might be questionable on the basis of standard laboratory tests—for example, hose tubes carrying aromatic gasoline.

Permeability

At room temperature the resistance of neoprene to permeability by gases—especially air—is usually reported to be six or seven times greater than that of natural rubber, but inferior to that of butyl rubber. In our investigation of possible neoprene tire innerliner stocks we recently completed tests which indicate that the permeability of neoprene increases with temperature less rapidly than butyl. At about 175° F.—a reasonable temperature for containing air under high-speed driving conditions—a typical black-loaded neoprene stock is no more permeable than the standard butyl tube stock with which it was compared.

Ozone Resistance

The ozone and weather resistance of neoprene has been proved over years of outdoor service, particularly in wire and cable jackets. Compounded specifically for ozone resistance, neoprene will hold up well at ozone concentrations as high as 100 parts per million—many times the maximum atmospheric levels ever reported even in California.

The electrical insulating properties are adequate for low-voltage service. On the other end of the scale, neoprene stocks can be made conductive for static discharge purposes without difficulty.

Resilience

Factors that are sometimes overlooked are the resilience and hysteresis properties of neoprene. In gum or lightly loaded stocks these properties are slightly inferior to those of natural rubber . . . but at higher loadings of filler, i.e., in the normal compounding range, neoprene stocks are often more resilient and cooler-running than the corresponding natural compounds.

Compression Set

A common reference point in specification compounding is compression set. From a practical consideration, resistance to compression set over a wide temperature range is probably much more important than the absolute value at any one temperature. Neoprene stocks—particularly those based on a W type—are outstanding in this respect.

Color Stability

One of neoprene's admitted deficiencies is color stability in light. Despite much research effort, no neoprene stock is completely free from a tendency to darken toward the tan. This discoloration is not completely disqualifying in light-colored stocks, as is perhaps best demonstrated by its large-scale use in white sidewall stocks as a 50:50 blend with natural rubber or other polymers. In spite of their tendency to discolor in light, neoprene compounds can be as free from staining as stocks of other elastomers.

Flame Resistance

The presence of about 36% chlorine in neoprene makes it the only general-purpose rubber with a significant degree of flame resistance. Like any organic material, it will burn if an external flame is applied, but—except when compounded with high concentrations of flammable ingredients—it will stop burning when the external heat is removed.

Versatility

At an average price of 40¢ a pound and a specific gravity of 1.23, neoprene is at an apparent economic disadvantage . . . but there three factors to consider before ruling out neoprene for this reason:

(1) Neoprene stocks can be very highly extended with filler and oil while retaining a surprisingly high-quality level.

(2) Neoprene can be blended with other rubbers to give medium-quality stocks at low cost.

(3) In the past several years there has been a definite trend toward greater acceptance of quality products at reasonable price differentials. This fact has been dramatically demonstrated in a variety of merchandising fields—automotive sales is a good example. There is every reason to expect that this will become a growing factor in the buying pattern for rubber products and that those products with established technical superiority will enjoy an increasingly stronger competitive position.

I started this discussion with a question in the back of my mind: Why use neoprene? The answer to this question lies, I think, in its versatility . . . it is undoubtedly the closest thing we have to an all-purpose rubber and can be considered at least for a great majority of the products made in our industry.

Hypalon

The basic requirement for any elastomer is the ability to be transformed from a workable plastic state to a tough, resilient form. This transformation is, of course, usually accomplished by means of a chemical reaction accelerated with heat. In most rubbers this required degree of reactivity is based on chemical unsaturation—double bonds—which in turn leaves the door open for other reactions which may limit the serviceability of the final cured product under severe use conditions.

Hypalon is a completely saturated rubber produced by reacting polyethylene with sulfur dioxide and chlorine. The resulting sulfonyl chloride groups are the reactive sites which make possible its vulcanization in the complete absence of double bonds. Most of the unique properties of Hypalon are directly related to this stable, oxidation-resistant structure. They include outstanding ozone resistance, excellent heat aging, a high degree of resistance to oxidizing chemicals, light stability, and good weathering properties.

Defining some of these properties a little more specifically—Hypalon has complete ozone resistance . . . a normally compounded stock has never cracked in ozone at any concentration. Its heat aging is probably 50° F. better than that obtainable with other general-purpose rubbers . . . or, expressed another way, this elastomer compounded for heat should retain a working degree of flexibility for as long as two weeks at 300° F. Its serviceability is further extended by the fact that during heat aging it does not become case-hardened or embrittled on the surface because of oxidation as do many other synthetic rubbers.

Although Hypalon should not be considered as a cure-all in handling strong oxidizing solutions, it can be used in nitric, chromic, and sulfuric acid service under conditions which would rapidly deteriorate other rubbers. This advantage is sufficient to justify its use in rolls, hose tubes, and tank linings. The limitations on the use of this chlorosulfonated polyethylene in oxidizing chemicals involve time, temperature, and concentration and can best be evaluated on an individual basis.

In the weather, ultra-violet degradation rather than straight oxidation is the prime enemy of Hypalon. Fortunately, light-screening pigments offer an effective defense, and stocks so compounded have held up in sunlight for several years without appreciable change.

The ozone and weather resistance of chlorosulfonated polyethylene can be carried over in part at least to more economical blends with other rubbers. White sidewalls are a good example of such an application.

As with most new materials, Hypalon has other interesting properties not readily predictable from its structure—a case in point, superior indentation resistance in heavily loaded stocks, a property used to advantage in floor tile.

One way to take advantage of Hypalon's properties at moderate expense is to apply thin films from solvent solutions. The elastomer is soluble in aromatic solvents and can be brushed or sprayed.

Summarizing very briefly, Hypalon offers a distinct superiority over general-purpose rubbers in resistance to heat, ozone, and oxidizing chemicals. Used alone or in blends, it offers for the first time the possibility of weather-resistant, color-stable rubber products.

Questions and Answers

Q. Discuss the design of compounds for maximum rubber-to-metal adhesion.

A. Much of the success of metal bonding lies in the techniques of handling and preparation. There are a few general rules of compounding—most of them dictated by common sense—which apply to neoprene, and in most cases to other rubbers. Naturally, excessive amounts of waxes, softeners, or other ingredients capable of causing a surface bloom should be avoided. As a matter of fact, even within compatibility limits high loadings of plasticizer are not recommended. The choice of filler is usually not critical, although some users find advantage in using some hard clay as part of the filler loading.

In order to assume adequate pressure at the metal-rubber interface during molding, very soft or thermoplastic stocks should be avoided. This can be done with filler loading or by choice and preparation of the polymer. In the cured stock, modulus should be as high as other requirements will permit in order to protect the bond from necking down, flexing, and mechanical working.

When bonding neoprene directly to brass, it is necessary to add sulfur either to the stock or to an intermediate cement. Even sulfur-modified neoprenes have insufficient sulfur to produce a good chemical linkage, and, of course, the W types have no sulfur at all. Choice of acceleration is important in brass bonding with sulfur—Permalux[15] or Thionex[16] DOTG combinations are preferred over NA-22,[17] which causes a definite lowering of adhesion values.

Methods of bonding Hypalon are similar to those used for neoprene, although the thermoplasticity of the former makes the problem of developing adequate bonding pressure a little more difficult. Neoprene and Hypalon cured in contact with each other adhere well; hence, one method of bonding the latter is by means of a neoprene tie coat or cement with a conventional neoprene primer on the metal.

Q. Discuss the design of compounds for best rubber ply adhesion.

A. In designing a neoprene compound for maximum tack and ply adhesion, several factors should be considered: (1) choice of neoprene type; (2) selection of softening and processing aids; (3) mechanical and chemical breakdown; (4) type of loading; (5) cure rate.

As a general rule, the G- or sulfur-modified types of neoprene give the best tack and knitting. Neoprene Type GRT is preferred in this group because of its crystallization resistance.

[15] Du Pont trade mark. Di-o-tolylguanidine (DOTG) salt of dicatechol borate.

[16] Du Pont trade mark. Tetramethyl thiuram monosulfide.

[17] Du Pont trade mark. 2-Mercapto-imidazoline.

Obviously, oils and waxes with limited compatibility should be avoided. Tackifying such as coal-tar oils, medium and low melting coumarone-indene resins, pine tar, wood rosin, and rosin derivatives have all been used for this purpose. In developing very tacky stocks there is always the risk of causing processing difficulties due to sticking to mill and calender rolls.

Possible solutions to this problem include carefully chosen release agents. Among materials which sometimes help strike this critical balance are natural rubber, low molecular weight polyethylene, and some microcrystalline waxes. In the latter group Superla[18] Wax has been outstanding, since it is a tacky wax which sometimes improves knitting at room temperature, but gives good release from metal at temperatures near its melting point. When stocks are to be plied up, it is often desirable to run the preceding operation at a fairly high temperature to eliminate nerve and shrinkage and to give smooth surfaces which can be intimately bonded.

Both mechanical and chemical breakdown may be used to improve ply adhesion. The G-types of neoprene respond most readily to either method. Accelerator 552[19] is a particularly powerful peptizing agent. The W types of neoprene resist both chemical and mechanical breakdown, although the latter is sometimes feasible.

Although as a general rule excessive loading of filler, particularly those giving stiff, boardy stocks, should be avoided, silica-type fillers give good cured ply adhesion in roll cover stocks. Zinc oxide and whiting promote a dead mushy consistency desirable in friction stocks.

Acceleration should be chosen to avoid any chance of incipient scorch on the surfaces to be bonded.

In some cases a tackifying solvent wash can be justified to insure ply adhesion. The use of a solvent solution of Accelerator 552 for sulfur-modified neoprenes is particularly effective.

In the case of Hypalon, many of the same principles apply. Hypalon is basically a dry, tack-free polymer, although the present material, Hypalon 20, is an improvement in this respect over the original Hypalon. Cements and solvent wash techniques may be more often required. The most effective solvent for this purpose is cyclohexanone. Cements containing rosin or rosin derivatives are also effective.

Q. Should more acceleration be used in a Neoprene WRT compound if the stock contains neoprene reclaim?

A. It is difficult to give an answer to this question which will apply to all situations. I would start out using no additional acceleration, for two reasons:

(1) Neoprene is probably never so completely devulcanized during a reclaiming operation as other general-purpose rubbers.

(2) Some neoprene reclaims actually increase cure rate when added to a neoprene compound prepared from fresh polymer. Naturally, under these circumstances a reduction in acceleration should be considered.

In those cases where the neoprene reclaim results from scrap within the plant, an alternative method of utilizing it would be to cure tightly and grind. The use of modest quantities of such ground scrap will probably not cause serious loss of physical properties and may often benefit processing.

[18] Standard Oil Co. of Indiana trade mark. Petroleum wax.

[19] DuPont trade marke. Piperidinium-pentamethylene-dithiocarbamate.

Nitrile Rubber

By W. J. Boyd

Xylos Rubber Co., Akron, O.

FOR many years compounders and design engineers were looking for a rubber that would resist greases, oils, and fuels. For the first quarter of this century they had only natural rubber and reclaim with which to solve their problems. After this period along came Thiokol polysulfide rubber and neoprene. Polysulfide rubber, generally speaking, had good oil resistance, but only fair physical properties, and neoprene, while possessing good physical characteristics, had only medium oil and fair fuel resistance properties.

Nitrile synthetic rubbers first became commercially available in the United States in the late 1930's. The nitrile synthetic rubbers were the first low-swell, oil-resistant rubbers with physical properties that would permit their use in commercial application. Their properties made them immediately attractive to the aircraft industry, but since the war, numerous other uses in the home and industry have been found for them.

Nitrile rubber production figures taken from the "Rubber Statistical Bulletin," Volume 10, August, 1956, published by the International Rubber Study Group, London, England, show that this production has increased from 7,781 long tons in 1945 to 32,623 long tons in 1955. Indications are that the latter figure will be exceeded in 1956.

Nitrile rubbers are copolymers of butadiene and acrylonitrile which are made by the emulsion polymerization process. The copolymers can be made by both the low-temperature polymerization process at approximately 43° F. and the hot process at 122° F.

Properties

Nitrile rubbers exhibit unsaturation to a degree somewhat lower than that of natural rubber. They are, however, capable of vulcanization with sulfur, and the vulcanization is influenced by accelerators and activators and reinforcing agents in the same manner as that of natural rubber and SBR. These nitrile copolymers are made in various ranges of bound acrylonitrile varying from 47% down to 18%.

It is necessary with nitrile rubbers as well as it is with the copolymers of butadiene and styrene to use reinforcing agents in order to obtain the highest physical properties.

For most applications the nitrile rubber compounds require the use of ester plasticizers. There are many types of these ester plasticizers with a wide range of prices which can be used. They impart various properties to the finished products, such as, for example, improving the low-temperature flexibility over what the compound could do without the plasticizer. The use of these low-temperature plasticizers imparts the factor of shrinkage in low aniline point oil to the part. Also, generally, the high-temperature resistance is impaired.

Another factor that must be considered in the use of these plasticizers is the fact that they may bleed from the cured part if too much is used. For this reason in many cases a blend of plasticizers is used. The other plasticizer may be one that has poorer low-temperature properties, but is not so extractable in oils and fuels, so that it prevents shrinkage of the part in low aniline point oils.

At times, polymeric plasticizers can be used where low-temperature flexibility is not a critical problem. Ordinarily 15 to 30 parts of plasticizer are used to 100 parts of nitrile rubber. This amount of plasticizer may be reduced in some cases to five parts or less where such a change may be required to meet specifications. This reduction may make the stock slightly harder to process.

The nitrile rubbers will cure with the normal sulfur, accelerator, and metallic oxide ratios commonly used for other rubbers.

In many cases it has been found necessary to use the so-called "sulfurless cure" in order to meet requirements of some present-day specifications. This "sulfurless cure" uses accelerators that will liberate sulfur at curing temperatures. It has been found that products using this "sulfurless cure" give improved compression set results and are better after immersion in oils than those having a normal sulfur cure.

To decide which type of nitrile rubber to use one must remember that oil resistance varies directly with the acrylonitrile content, while low-temperature flexibility is inversely proportional to the amount of acrylonitrile present.

Compounding

In compounding of nitrile rubbers we must consider oil and fuel resistance in addition to normal and aged physical properties, low-temperature flexibility, and compression set. The design engineer should be realistic in these requirements and not ask for very-low temperature service along with high oil resistance as it may make a specification almost impossible to meet.

Wherever possible, the oils and fuels specified by ASTM D 471 should be used for specification purposes. These oils and fuels cover the aniline point range of most commercial oils and fuels. Much data have been gathered on the behavior of nitrile compounds in these materials, and it is easy to predict how a specific compound will behave in an immersion test.

The nitrile rubbers are compatible with natural rubber and most synthetic rubbers, with the exception of butyl. Mixtures of natural, natural and SBR type reclaims, and SBR type rubber can be used to control swelling in oils between different ranges for different applications.

Nitrile rubbers are also compatible with commercial grades of polyvinyl chloride and phenolic resins to give products with interesting properties. Nitrile rubber is used with vinyl resins as a non-bleeding plasticizer for film. Nitrile rubber combined with phenolic resins will make a semi-hard rubber with good oil resistance.

Nitrile rubbers can be blended with high styrene copolymers which improve the molding characteristics with a resultant decrease in resistance to oil and fuels.

Applications

Let us consider the various applications where the desirable characteristics of nitrile rubber enable them to be used.

In the aircraft industry there are many applications such as hydraulic fittings, fuel lines, and various types of seals. These are made to very close specifications which can be met only with nitrile rubber. Some of the AMS[20] specifications and military specifications pertaining to aircraft are met only by the use of various types of nitrile rubbers. Another large usage of nitrile rubber in the aircraft industry is in the fuel cells which could not be made without the use of nitrile rubbers.

The automotive industry uses nitrile rubbers in many applications. Some of these applications are covered by the ASTM D 735 SB classification. Other compounds have been developed for the bushings and seals for the cooling system of automobiles. This is a point where water resistance has to be considered, in addition to the oil resistance. This water resistance can be met with nitrile rubbers through proper selection of fillers and reinforcing agents. Another important use for nitrile rubbers in the automotive field is in the seals for automatic transmissions. This application requires parts resistant to transmission oils at 250 to 300° F. with low set and fair low-temperature flexibility.

The use of nitrile rubber in O-ring seals has grown by leaps and bounds over the past years. Applications for this type of seal have been developed throughout industry.

There are a number of rolls covered with compounds containing nitrile rubber. This type of covering is used where oils and solvents will come into contact with the rubber surface. In this application it is usually required that the compound be adhered to a steel core. This requirement can be met covering the surface of the steel core with various commercial bonding agents. The plasticizers used in formulating the nitrile rubber compound must be used in low concentrations. The use of non-bleeding plasticizers is recommended.

Numerous applications in the food industry use nitrile rubber. These compounds are used for jar seals, belts, and milking-machine inflations, to mention a few. On the milking-machine inflations it is interesting to note that previously these were made from natural rubber. After switching to nitrile rubber these inflations lasted approximately 50 times longer.

For use in the oil fields, compounds can be designed to have high tensile strength, and resistance to the entire aniline point range of oils.

[20] Air Materiel Specification, Society of Automotive Engineers, New York, N. Y.

Nitrile rubber can be compounded with light-colored pigments and colors which have sunlight resistance and which give service in products such as sink mats, which require light colors for sales appeal.

High styrene resins can be combined with nitrile rubbers for articles such as shoe soles requiring high hardness with good abrasion resistance along with oil resistance.

Cements and adhesives can be made from nitrile rubbers directly, or by using blends of nitrile rubber and phenolic resins, etc. Such cements have good bond strength and good heat resistance in addition to other properties. Industrial applications of nitrile type cements are for bonding nitrile stock to metal, glass to glass, leather to leather, brake lining to brake shoes, etc. The most commonly used solvents are methyl ethyl ketone, and toluene. Other solvents, however, may be used for special applications.

One of the largest usages of nitrile rubber is in the form of latex. Films from dried nitrile rubber latex have higher physical properties than those of SBR type latex films; however, to get the best physical properties, these latices must be compounded. Commercial applications using nitrile latex are in the manufacture of prepared papers, leather finishes, adhesives, etc.

There are many other applications where nitrile rubber can be used. I have mentioned only a few. In general, for any application where oils or fuels may come into contact with the rubber part, the nitrile compounds should be investigated.

At the present time, the nitrile rubber industry is being asked for rubbers resistant to temperatures from 400° F to –100° F. Our present range is 300 to –80° F., however, we can go to 350° F. when the nitrile rubbers are immersed in some oils. We are endeavoring to meet these demands by both development of polymer and through use of present and new compounding materials and techniques. Other problems that are giving us some trouble are resistance to diester oils and oils containing additives that seem detrimental to nitrile rubbers.

In closing I would like so say that all nitrile rubber manufacturers have service laboratories that will help you with any problem concerning the use of nitrile rubbers. It is helpful to them to have available the complete specification or service requirements of the rubber parts involved before they give advice on your problems.

Questions and Answers

Q. Discuss the design of compounds for maximum rubber-to-metal adhesion.

A. Many times a nitrile rubber compound meeting a specification has to be adhered to metal for its final application. If this fact is known, the compound can be designed so that excellent adhesion to metal is obtained, and the compound can still meet the specification for the rubber part.

One of the main factors to remember for such an application is to keep the plasticizer ratio low, usually 10 parts or less of a non-bleeding plasticizer. In order to have a processible compound with this low plasticizer ratio it is necessary to use the "easy processing" nitrile polymers. Waxes and other materials which bleed to the surface should be avoided in such compounds.

We have found that fillers or reinforcing agents have some effect on this rubber-to-metal adhesion. A nitrile rubber compound containing seven parts of plasticizer, and 60 parts of filler to 100 parts of nitrile rubber (other ingredients in normal amounts), and employing a sulfurless cure, showed that most carbon blacks did not give the adhesion to metal that was obtained for compounds containing whiting, clay, and calcium silicates. Compounds containing hydrated silica gave excellent adhesion. Many times these fillers that give good adhesion can be combined with the blacks to obtain the general properties as well as the adhesion to metal required.

The curatives used have some effect on this rubber-to-metal adhesion. A compound using 10 parts of plasticizer and 60 parts of SRF black to 100 parts of nitrile rubber showed that a sulfur cure was slightly better than a sulfurless cure. Excellent results were obtained using tetrachloro-para-benzoquinone, also dicumyl peroxide as curing agents.

The above comments are based on using commercial rubber-to-metal adhesives applied to a sandblasted or etched surface and then degreased.

Q. Discuss the design of compounds for best rubber ply adhesion.

A. Nitrile rubber compounds are generally drier and less tacky in the uncured state than compounds of most other rubbers. To improve this tack soft blacks with a fairly high proportion of plasticizer (20-30 parts) should be used. The plasticizer used should be of the ester type and should not exceed the solubility limits of the particular plasticizer in the nitrile rubber used, as bleeding of the plasticizer from the uncured stock will destroy the tack. For this reason many times a blend of two ester plasticizers is used in nitrile compounds.

Small amounts of tackifying resins are sometimes used in nitrile rubber compounds to improve the tack and ply adhesion.

Q. Discuss the physical properties of combinations of other synthetic rubbers with nitrile rubbers.

A. As stated earlier in my talk, nitrile rubbers are compatible with most synthetic rubbers except butyl. Normal physical properties of such mixtures are generally close to those obtained for all-nitrile rubber compound with the same compound ingredients, provided a homogeneous mixture of the nitrile rubber and the other synthetic rubber is obtained at the initial mixing stage. Oil resistance of such mixtures is usually less than that obtained for an all-nitrile rubber compound.

Exceptions to this statement would be where nitrile rubber is combined with an organic polysulfide synthetic rubber where the normal physical properties are reduced, and oil and fuel resistance is increased.

Q. Discuss nitrile compounds designed for low gas permeation.

A. The largest factor in designing a

nitrile rubber compound for low gas permeation is the amount of acrylonitrile in the polymer. The higher the nitrile content the lower the gas permeation. Following are some figures taken from the literature, with natural rubber with 100% permeation taken as a base.

Recently polymers are being produced having 45-47% nitrile content which would have much less permeation to gas than the 38-40% nitrile polymer.

TABLE 1

	% Permeation
20-22% nitrile content	33
30-32% nitrile content	8.5
38-40% nitrile content	3.4
Butyl rubber	4.8

As to compounding, gas permeation is reduced by small amounts of moisture and increased combined sulfur. Curing temperature, amount of milling, and plasticizers have little effect on permeability.

Types of Styrene-Butadiene Copolymers and Their Applications

By J. F. Svetlik

Phillips Chemical Co., Akron, O.

PRIOR to World War II the United States was almost totally dependent on natural rubber for general-purpose uses. When the enemy cut our supply lines, we were in critical need of rubber and had to resort to rationing. Steps were taken to develop synthetic rubber with utmost haste, and with government financing and tremendous contributions of knowledge, skill, and hard work by representatives of rubber, chemical, and petroleum companies and research organizations this feat was accomplished in record time. The styrene-butadiene type copolymers were selected for production in the plants, and these were designated GR-S (Government Rubber-Styrene). The term synthetic rubber has been applied to these polymers although it should be recognized that these are only one of the types of synthetic elastomers on the market.

In the early stages of GR-S production few people envisioned the popularity that styrene-butadiene copolymers enjoy today. Their many desirable features make them the preferred rubbers for numerous applications. A noted authority reported recently that irrespective of price, natural rubber is preferred for technological reasons in applications comprising 27% of all rubber consumed, styrene-butadiene copolymers are preferred for 38% of all applications, and the remaining 35% can be either synthetic or natural rubber, depending upon the relative price. Besides enjoying a superiority over natural rubber in certain applications the styrene-butadiene copolymers have the advantage of being stable in price.

In 1955, of the general-purpose type rubbers consumed in the United States, 46% was natural rubber and 54% was the styrene-butadiene coploymers. Greater quantities of synthetic would have been consumed if more had been available. Why, then, this decided swing toward the use of styrene-butadiene rubbers? Beyond doubt the stable price was a big factor. Other factors are: (1) better roadwear performance in passenger tires, permitting production of longer-wearing tires less subject to cracking failures; (2) better aging resistance; (3) greater uniformity which improves factory processing and eliminates product quality variations; and (4) greater processing safety, to name but a few.

The two principal grades of SBR are designated as "hot" or "cold," depending upon the polymerization temperature. A number of polymers exist within each group differing in such details as styrene-butadiene ratio, coagulation technique, emulsifier, antioxidant, etc. Masterbatches containing black, oil, or black and oil are also available.

While initially all of the SBR was produced at 122° F., at present approximately 75% of styrene-butadiene copolymers are produced at 41° F. The greater demand for cold rubber is a result of the much better tensile strength, greater elongation, approximately 20% greater wear resistance, lower hysteresis, superior resistance to crack growth, and smoother extrusion.

Hot SBR

Hot SBR's possess better breakdown characteristics during mixing than cold SBR's and are preferred in certain mechanical goods applications. Staining types (1000, 1002, 1004) are used in applications where contact or migration staining is not a problem such as in black tires and certain extruded and molded mechanical goods. Slightly staining 1001 is used similarly and also in shoe soles and heels. Non-staining types 1006 and 1011 are used in those applications where the item itself must not discolor or stain items or finishes with which it comes in contact. Non-staining carcasses, mechanical goods, footwear, sporting goods, toys, surgical goods, and white sidewalls are typical applications.

Cold SBR

Cold rubber, 1500 type, is used very widely in tire treads and other applications requiring superior tread wear and excellent physical properties. Slightly staining 1501 is used similarly to 1001, but again is favored for uses requiring better physical properties. Non-staining 1502 is used in applications paralleling those of 1006, but also finds considerable use in tires and other dynamic applications.

Special SBR's

A group of special-purpose rubbers (1007, 1016, 1019, and 1503) are made almost primarily for the wire and cable trade. To possess the desired electrical properties these polymers must have a low ash content, which is obtained by glue coagulation, and in some cases the polymer is also processed through an extruder to reduce the ash still further. For electrical use the rubber must not change in dielectric properties if exposed to moisture —hence the need of having a low ash content to reduce the tendency to absorb moisture.

High Mooney viscosity 1012 and 1022 polymers are specialty polymers developed primarily for adhesives and some special applications. Type 1010 is a low Mooney type designated primarily for blown sponge applications. Because of its low viscosity less breakdown is required.

High styrene rubbers are used in can closures, adhesives, soles and heels, etc. These polymers (1013, 1014 and 1021) possess poor freeze resistance.

Low styrene rubbers (1015, 1023, 1504, 1505) are used in applications requiring excellent low-temperature resistance such as in Arctic service. These rubbers contain from 3.5 to 13% bound styrene. Poorer processing characteristics result from lower styrene content; hence these polymers would be slightly harder processing.

SBR Masterbatches

Carbon black masterbatches enjoy wide popularity principally because of the cleanliness and fast mixing which are possible. Because the carbon black is already dispersed no black contamination results even if mixing is conducted immediately adjacent to white stocks, and also because the black is already dispersed the mixing cycle can be greatly shortened, and even a one-pass mix is sometimes used. FEF black reinforced types 1104 and 1605 are used primarily in molded, extruded, and calendered goods where the excellent smooth-out and flow characteristics of FEF black are desired. HAF black reinforced types 1600, 1601, and 1602 are used widely in tires and camelback, but the usage is increasing progressively in mechanical goods where the greater reinforcement of HAF black provides better physical properties.

Oil masterbatches are very widely accepted because of the economical compounding which they permit. The combination of high oil level and increased black loading permits attainment of satisfactory properties at much lower compound costs. These masterbatches are available with 25 or 37.5 parts of naphthenic, aromatic, or highly aromatic oils. The latter two types of oils are preferred for tire use or other applications requiring splicing and similar fabrication because the oils have less tendency to migrate. Of all cold rubber produced, approximately 25% is now oil-extended. Uses include tires, molded and extruded mechanical goods, and camelback. The non-staining types are also used in shoe soles and heels, floor tile, toys, etc.

Oil-black masterbatches contain 25 parts oil and more recently 37.5 oil and 50 parts HAF black. These materials combine the advantages of black masterbatches with the economics of oil-extended rubber and find largest application in tires and mechanical goods.

Comments

A few general comments not covered elsewhere follow: (1) Copolymers contain-

ing staining-type antioxidants possess greater resistance to oxidation and less tendency to overcure. (2) Oil masterbatches containing highly aromatic oils give higher tensile strength than those containing naphthenic oils, but the former stain. (3) Rubbers containing fatty acid are faster curing than those containing rosin acid.

While the above discussion is at best only a superficial coverage of the subject, because of the limitation of time, it is hoped that the major advantages of styrene-butadiene rubbers have been conveyed.

Questions and Answers

Q. What are the factors that limit the lower raw viscosity limit of 1500, 1502, 1710, and 1712 SBR types in tire treads?

A. The Mooney viscosity ranges in existence for the different synthetic rubbers are believed to be a compromise between processibility, performance, and polymerization plant handling characteristics.

If the Mooney viscosity is lowered, the rubber becomes easier to process in the factory, but some loss may be suffered in the physical properties such as tensile strength and abrasion wear. Also, lower Mooney viscosity polymers tend to coalesce in the copolymer plant dryers, which tendency contributes to drying difficulties.

On the other hand, use of higher Mooney viscosity materials will improve their handling characteristics in the copolymer plants and may give slightly better physical properties; but owing to their greater toughness, the rubbers would be more difficult to process in the factories where they are utilized.

Q. In compounds where high styrene resins are added for processing and hardness, is it possible to replace SBR 1006, which is approximately 24% styrene, with one such as SBR 1013, which is about 44% styrene, and either eliminate or reduce the added styrene in the compound?

A. The substitution of a high styrene copolymer for a portion of SBR 1006 to reduce styrene resin requirements has been done. Such compounds, however, would probably have a poorer balance of properties. The high styrene resin offers a degree of reinforcement which would not be obtained with a polymer like SBR 1013. It is also postulated that a blend of 1006 and 1013 with lower styrene resin would have poorer low-temperature flexibility than a compound based on 1006 with a higher styrene resin content, if such were a service requirement.

Q. Would oil-extended polymers have a critical storage temperature both in the unvulcanized compound form and the cured product form? We have evidence that oil migration increases vary rapidly above 90-100° F. The oil migrates into the natural rubber cushion used in camelback.

A. The question of oil migration in oil-extended rubber has received considerable attention by many people. In the early days of oil-extended rubber some reports were received that the oil migrated from oil-extended treads to the carcasses with the result that weaknesses developed. Difficulties in splicing were also attributed to oil migration. When the switch was made from naphthenic to the highly aromatic type oils, however, this difficulty apparently disappeared.

A large amount of camelback is being produced from rubber containing 37.5 parts of highly aromatic oil, and no particular difficulty has been reported with deterioration or weakening of the cushion gum; hence it is not judged to be a serious problem at present. The highly aromatic oils are more soluble in the rubber and therefore have less tendency to migrate. The effect of temperature on rate of migration is not known definitely. If the temperature is a factor in oil migration, this might present a problem in the South where higher storage temperatures are encountered.

Improved Color of Non-Staining SBR Type Rubbers

By F. J. Sackfield

American Synthetic Rubber Corp., Louisville, Ky.

OVER the last several years the commonly available technical literature has abounded with articles completely documenting the theoretical and technological aspects of styrene/butadiene (SBR) copolymerizations. Rather than attempting a review of this work, I have taken the liberty of deviating from my assigned topic. I have chosen to speak briefly on a subject which I feel may well be one of the significant achievements of the current year in the commercial production of SBR rubbers. I refer to the significant improvement now evident in the bale appearance of the non-staining types.

Whenever the relative merits of natural and SBR rubbers are discussed, it is usual to see poorer color of the vulcanizate in light-colored stocks listed as one of the disadvantages of the SBR type. In view of the progress made, particularly during the current year, in improving the color quality of the non-staining SBR types, this disadvantage seems likely to disappear.

Catalyzed by the initiative of one or two of the copolymer plant operators who introduced improved non-staining types to the trade, attention was soon focused on this problem by the remaining operators producing competitive products. The results have been both quick and dramatic. Some of the previously designated "non-staining" rubbers are now referred to as "water-white."

The improvement in bale color encompasses the entire range of non-staining rubbers, that is, hot, cold, and oil-extended types.

During the decade or so that the copolymer plants were operated under the overall jurisdiction of a governmental agency, manufacturing formulations were specified for each type of rubber authorized for production. Specifications covering certain chemical and physical characteristics of the products were also ordained.

Ordinarily, the difference between a staining and a non-staining type was based on the type of stabilizer and, in some cases, of the shortstop specified in the formulation. A measure of the degree of bale color or an range of color uniformity never appeared as a finished-product specification. Such a test to be meaningful would have to be accurate and precise. To meet the requirements for speedy classification of production in the copolymer plants, it would be necessary that test results could be quickly obtained. The unavailabality of a color test to meet these qualifications explains its absence in the usual list of raw polymer specifications for the non-staining types. Within the tolerances allowed for deviation from the established formulations and with the absence of competition for customer sales, no consistent major differences in bale color of the same non-staining product made in different copolymer plants was apparent during the period of government ownership of the plants.

With the advent of private operation of the copolymer plants and spurred on by the recent excess of supply over demand, a strong competitive spirit has developed. In the form of either newly designated products or in the nature of betterment of existing ones, significant bale color improvement can be noted.

The hot rubber type, SBR 1006, has been particularly adaptable to color improvement. Improvement in the cold type, SBR 1502, has been noted when a change from the iron-pyrophosphate to the sulfoxylate type of activation system has been made. Improved bale color of the naphthenic oil-extended types has been made by the substitution of lighter colored, but more highly volatile extender oils.

The improved non-staining rubbers should be of prime interest to compounders engaged in the manufacture of white or light-pastel shaded products or where improved resistance to staining and discoloration is required.

Questions and Answers

Q. Is it possible to produce a cross-linked rubber such as SBR 1009 having the compounded physical properties equal to a polymer such as SBR 1006? (Such a polymer at a competitive cost with SBR 1006 would have application in 30-60 durometer hardness extruded stocks because of low die swell.)

A. It has been demonstrated that it is commercially feasible to produce a cross-linked rubber with a tensile of 2500 to 2800 psi. with lower swelling index and better extrusion characteristics than SBR 1009. This rubber has tensile values 200 to 500 psi. lower than SBR 1006, but about 500 to 800 psi. higher than SBR 1009.

Owing to the extra production costs involved in manufacturing this improved cross-linked rubber, it is doubtful that

it could be profitably sold at a price competitive with that of SBR 1006.

Q. Oil-extended rubber degrades on prolonged storage (Mooney drops to low values). Is there any oil or additive that can be used to avoid this situation?

A. The period of warehouse storage before breakdown of unvulcanized styrene/butadiene rubbers begins and the extent of such breakdown seems to be a function of the characteristics of the extender oil used and of the type and the amount of metallic impurities in the rubber.

Two reports[21,22] have recently been published pertinent to this problem. One of these reports[21] concludes that when stored for sufficient time at 140° F., all cold rubber-oil masterbatches will probably break down. The extent of breakdown and the degree of ultimate breakdown is less the more saturated the oil-extender used. This fact would indicate that, in general, the so-called naphthenic group of extenders should provide more stable rubbers than the aromatic or highly aromatic.

The other report[22] suggests that breakdown can be minimized by reducing as low as possible the quantities of metallic impurities such as iron, manganese, and copper. This fact would indicate that better stability should result with oil-extended rubber produced from a sodium formaldehyde and sulfoxylate activated latex than from an iron-pyrophosphate activated type.

Silicone Rubber

By Thomas D. Talcott

Dow Corning Corp., Midland, Mich.

SILICONE rubber is a special-purpose rubber and is intended for use in many applications where other rubbers fail. Its primary advantages are: resistance to temperature extremes, weathering characteristics, and excellent electrical properties. It is the only elastomer available that is useful from below −130° F. to +600° F.

At present, silicone rubber is used in many widely varying applications. Transmission seals made of silicone rubber resist the oil used and the heat developed in the newer, more powerful automobiles. Electrical cables and other electrical equipment insulated with silicone rubber resist ozone, high temperatures, moisture, and corona. Silicone rubber is also used for roll coverings, providing release and high-temperature resistance in processing plastics and foods. Silicone rubber aircraft seals and ducts resist the extremely high and low temperatures encountered by modern planes and rockets. Artificial parts for implantation in the human body are made of silicone rubber because of its physiological inertness. Silicone rubber baby-bottle nipples resist sterilization temperatures.

Silicone rubber has better hot strength than any other elastomer at temperatures above 250° F. Development of silicone rubber tires for use on high-speed aircraft has been initiated.

Silicone rubber is made from silica rock. SiO_2, a very inert inorganic material, is the basic raw material. In fact, including the filler, silicone rubber averages about 75% by weight of silicon and oxygen, the elements in silica rock. The basic polymer chain is made of alternating silicon and oxygen atoms. The two other valences of silicon are occupied by organic radicals such as methyl, phenyl, or vinyl. The polymer is a very high viscosity, water-clear fluid.

The compounding of silicone rubber is relatively simple compared to that of organic rubber. Standard rubber compounding equipment is used. To the polymer are added heat stable fillers such as silica, titanium oxide, zinc oxide, diatomaceous earths, etc., and an organic peroxide to cross-link or vulcanize the rubber. Vulcanization is accomplished with the peroxide by a free radical reaction through the methyl or vinyl groups on the polymer chain. Fumed or precipitated silicas such as Cab-O-Sil,[23] Santocel,[24] HiSil X303,[25] and Valron Estersil[26] give the highest strength stocks. Vinyl groups in the polymer improve the compression set of silicone rubber without the use of toxic additives and also make possible vulcanization with less reactive peroxides. Additives such as iron oxide and ferric octoate improve the heat stability of silica filled stocks.

Silicone rubber in the fully compounded form is available from the various silicone manufacturers in a wide variety of stocks. Compounds are available for molding, extruding or tubing, calendering, wire coating, dispersion coating, impregnating, and encapsulating.

In addition, the basic gums are available to the industry, as well as a partially filled gum to which fillers and vulcanizing agents may be added. A high vinyl content gum is available for blending with organic rubber.

Room-temperature vulcanizing silicone rubber is available for caulking and potting applications. Very recently, a fluorosilicone rubber was announced which gives excellent resistance to solvents and oils. The wide temperature limits of silicone rubber are retained. This new fluorosilicone rubber widens still further the applications of silicone rubber.

In the 12 or so years that silicone rubber has been in existence, tremendous improvements have been made in it, and continuing research and development promise still better compounds.

Questions and Answers

Q. Is it possible to extrude silicone rubber without additional equipment? Is there information available as to compounding and processing silicone rubber on standard rubber equipment?

A. Silicone rubber requires no additional equipment for compounding and fabrication. Some silicone rubbers can be hot-air vulcanized, that is, vulcanized continuously in a hot-air tube after extruding. Satisfactory extrusions can be made using simple plate dies. Optimum extrusion rates can be obtained by the use of special screws. Complete information relative to fabrication is available from the silicone rubber suppliers.

Q. Can Kel-F elastomer compounds be formulated which are suitable for use in red fuming nitric acid and JP-4 fuel at temperatures from −65 to +160° F. and ambient air temperatures of −65 to +300° F? Difficulty has also been encountered in obtaining elastomers which are suitable for dynamic and static seals in diester lubricants (MIL-7808) and silicate ester hydraulic fluids (Oronite 8515) at temperatures up to 400° F. and yet be flexible at −65° F. Has any panel member knowledge of such a compound? If so, who is the manufacturer, and what is his designation?

A. The new fluorosilicone rubber will withstand the temperature limits specified in JP-4. It is actually flexible down to −90° F., which is 25° F. below the limits mentioned. Immersion test results in JP-4 fuel at 160° F. are practically the same as test results at room temperature, indicating the upper temperature limit is higher than that specified. No data are available on red fuming nitric acid. The new fluorosilicone rubber will also resist diester lubricants from −90 to +350° F. and silicate ester hydraulic fluids to almost 400° F. Oxidation of diester oils at test temperature may be part of the reason for the poorer resistance and is being studied.

The fluorosilicone rubber is available in limited quantities from the Dow Corning Corp. and is designated Silastic LS-53.[28]

Q. Discuss the design of compounds to withstand hot phenols and gamma radiation deterioration.

A. Resistance of the types mentioned above is dependent upon the polymer used and the time and the temperature of exposure. Hot phenols would probably deteriorate the rubber; cold phenols would probably show less deterioration. Silicone rubber, either the regular types or the new fluorosilicone type, is further cross-linked by exposure to gamma radiation.

Q. Discuss the design of silicone rubber compounds for maximum metal adhesion.

A. Most silicone rubbers are similar as far as adhesion is concerned. At the present time, good adhesion is obtained by the use of primers. Lord primer, Chemlok 603,[27] is good. Surfaces must naturally be thoroughly degreased.

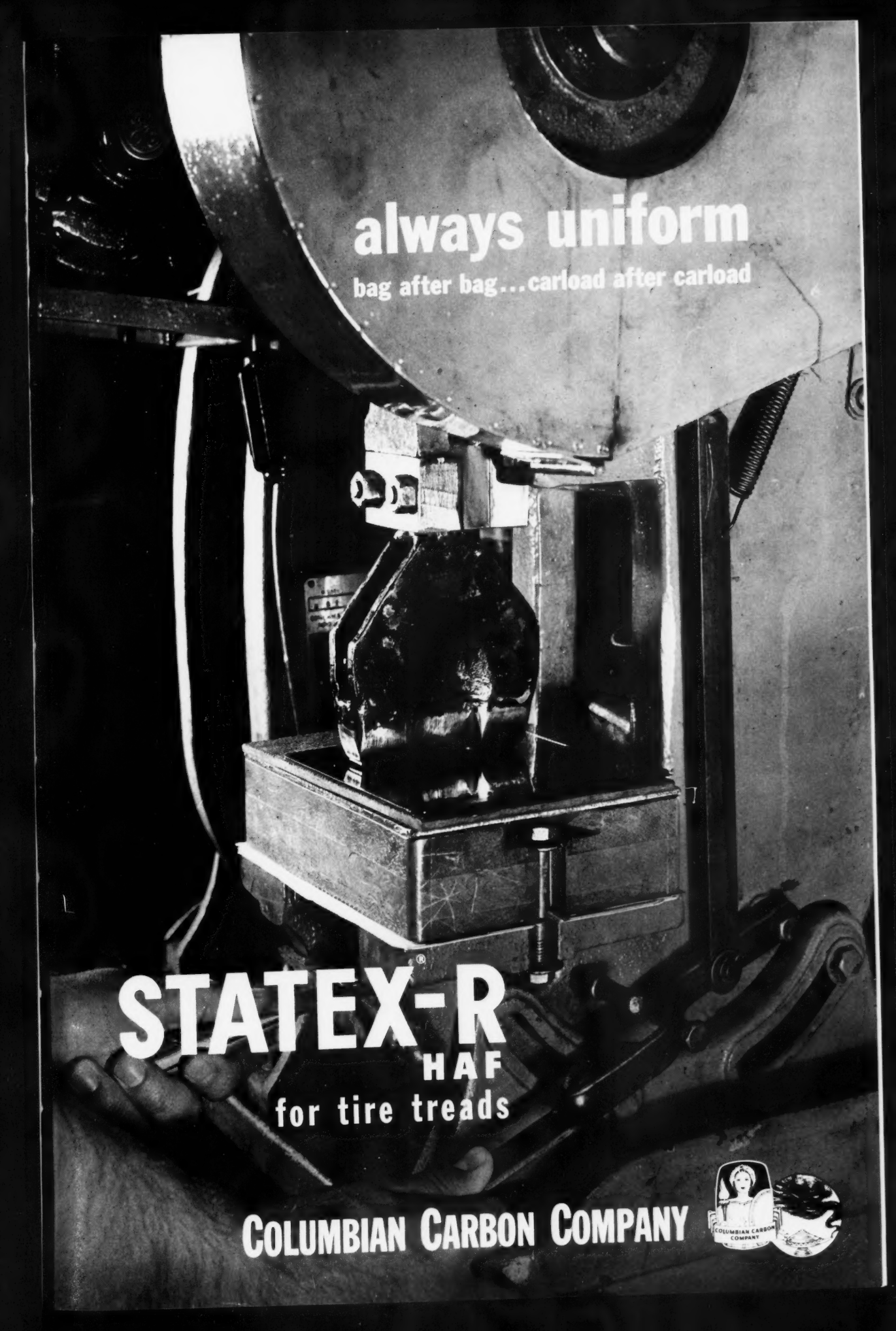
Q. Is it necessary that silicone rubber be kept separate from other stocks?

A. Yes!! Impurities, organic in nature, may poison the reaction of the peroxide similar to the poisoning that occurs with SBR and butyl rubber. Impurities will also harm the high-temperature stability. Many fabricators have set up separate facilities for silicone rubber, but if the equipment is to be used for both organic and silicone rubber, it should be very thoroughly cleaned prior to introducing the silicone.

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[21] W. K. Taft, A. D. Snyder, J. T. Duke, H. R. Mooney, *Ind. Eng. Chem.*, 48, 336 (1956).
[22] J. M. Mitchell, W. H. Embree, R. B. MacFarlane, *Ibid.*, 48, 345 (1956).
[23] Godfrey L. Cabot, Inc., trade mark.
[24] Monsanto Chemical Co. trade mark.
[25] Columbia-Southern Chemical Corp. trade mark.
[26] Du Pont trade mark.
[27] Lord Mfg. Co. trade mark.
[28] RUBBER WORLD, Oct., 1956, p. 124.




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Akron Group January Meeting Program: Symposium on Testing; Tennyson Guyer—I



Moderator Cooper and panelists

A symposium on "Physical Testing in the Rubber and Plastics Industries" was held as part of the program of the Akron Rubber Group at its meeting on January 25 at the Sheraton-Mayflower Hotel, Akron, O. The Group was fortunate in having as an after-dinner speaker, Dr. Tennyson Guyer, Ohio's Ambassador of Good Will, whose talk, entitled—"The Life of Your Time," was very well received. Dr. Guyer is executive assistant and director of public relations for the Cooper Tire & Rubber Co., Findlay, O.

L. V. Cooper, Firestone Tire & Rubber Co., was moderator for the panel discussion on physical testing. The panelists and their subjects follow: David C. Scott, Jr., Scott Testers, Inc., "Equipment"; John T. Blake, Simplex Wire & Cable Co., "Plastics and Insulated Wire"; John H. Dillon, Textile Research Institute, "Fabrics"; John W. Liska, Firestone, "Tire Compounds"; Sherman R. Doner, Raybestos-Manhattan, Inc., "Mechanical Goods"; and W. Newlin Keen, E. I. du Pont de Nemours & Co., Inc., "Specialty Rubbers." The accompanying photograph shows the moderator and the panelists for this symposium.

After an introduction to the symposium by the moderator, each of the panelists gave a short talk on the subject assigned to him. A question-and-answer period followed.

H. M. Brubaker, Witco Chemical Co., Group chairman, presided at the dinner-meeting. It was reported that membership of the Akron Rubber Group now totals 1,564, in contrast to 1,415 in 1956.

K. M. Garvick, Mansfield Tire & Rubber Co., most recent past chairman, introduced the Group's 1956-57 scholarship winners at the University of Akron.

It was also announced that the Group's advanced course in rubber technology at the University of Akron had been oversubscribed.

I. J. Sjothun, Firestone, chairman of the Group's program committee, introduced Dr. Guyer.

PHYSICAL TESTING IN THE RUBBER AND PLASTICS INDUSTRIES

Introduction

By L. V. Cooper

The Firestone Tire & Rubber Co., Akron, O.

THE object of all physical testing is to predict accurately from laboratory tests the service life of the finished product. Testing incoming materials and control of batches during processing insure a finished product that is consistent and at a definite quality level. Correctly evaluating new materials against the material currently in use makes possible increased quality or the same quality at a lower cost.

The first physical testing machines were human arms and teeth. By trying to flex a strip of rubber the first tester gained a fair idea as to modulus, tensile, and tendency to take a permanent set. A good chew on the corner of the slab gave a check on hardness and resistance to tear and cutting. Even today there are those who say that the "bite" test is the best cutting and tearing test we have (that is, if you have your own teeth).

During the past hundred years, and particularly the past forty, many machines have been devised to put a numerical evaluation on certain properties of materials and combinations thereof. Some machines evaluated properties no longer needed today. For instance, the soft rubber to hard rubber adhesion so necessary in solid tires is a dead item today, since the rubber-to-metal adhesion in present mechanical goods is now direct adhesion.

I need not tell you that the high speed service demanded of tires, the skin temperatures developed on the surface of planes and missiles traveling faster than the speed of sound, the development of many rubber-like material industrial applications and other factors have caused a change in the concept of physical testing, especially within the last ten years. Our panel will discuss a few of these as the questions you submitted are answered.

One of the major problems in physical testing concerns personnel—not only as to the number on the staff, but what type of people shall be employed. One company feels that physical testing work shall be a first-year training course for young engineers. At another company, it has become an "old folks' home"—the place where near-pensioners or physically handicapped are taken care of until they quit.

Edison once said that progress comes as a result of 2% inspiration and 98% perspiration, and it is admitted that the physical testing division is the perspiration part of progress. However, a physical testing division which simply cranks out routine results is not much of an asset to any company. The more desirable condition is a staff which not only can aid others, but has the ability, time, and facilities to design new equipment to do a better job of predicting probable service life.

Financial conditions are satisfactory in the rubber industry at present, and companies are willing to stand the expense of large tire road-test fleets. Should conditions change, pressure will be brought to bear to use laboratory tests to screen thoroughly proposed road-test possibilities, and the company with the most advanced and complete laboratory equipment will have a distinct advantage.

Equipment

By David C. Scott, Jr.

Scott Testers, Inc., Providence, R. I.

AN INSTRUMENT manufacturer tries to anticipate the requirements for the evaluation of physical properties and to develop equipment for fulfilling them. To further permit the compounder to progress further with his activities, we try to fur-

nish him with the information necessary for controlling the processing of his materials. The accent now seems to be on the stabilization of physical properties. This, we believe, has been brought about through two factors encountered.

The first is the excessively high temperatures generated in the rotating members of aircraft propulsion equipment, or due to the skin friction generated within the units being driven at high speed.

The second is the obvious limitations that present themselves when standard equipment is taken into new areas, and the conditions reflect a deficiency in one or more physical properties.

The military has indicated to all of us that it is not unusual to experience a temperature of —50° F. in the Arctic and Antarctic regions. To take care of these extreme temperatures it has been necessary for the rubber compounder to adjust his compounds to a point where the materials will be acceptable at these temperatures. Some equipment, such as gaskets, shock absorbers, etc., which has these compounds incorporated into it, is used in aircraft which has rotating equipment generating terrific heat when in operation. Inasmuch as the aircraft flies at extremely high speeds, the surface frictitons on the members subjected to wind again generate extreme temperatures.

We instrument makers, in trying to keep pace with these requirements, offered as early as 1946 a tensile tester with equipment suitable for producing testing temperatures of from —70 to +350° F. After the Arctic operations had been conducted by the Army in the late Forties, we offered an instrument for evaluating the brittleness or freezing point of elastomers. The American Society for Testing Materials has incorporated the use of this instrument as standard procedure in one of its specifications. This instrument again is capable of producing temperatures within the conditioning bath of down to —120° F.

About two years ago the B. F. Goodrich Co. Research Center at Brecksville, O., adapted a block of aluminum as a conditioning bath through the use of electrical heat. The advantages of this conditioning bath enabled high temperatures to be obtained through a safe, clean, and relatively free-from-maintenance means at a temperature tolerance almost unbelievable. The big feature incorporated into this apparatus was the complete segregation of the individual samples during their subjection to high temperature. The complete segregation of the samples permits each sample to be evaluated on its own merits. The samples are, therefore, prevented from being further deteriorated or bolstered, as the case might be, by outside influences generated by dissimilar samples being tested within the same container. These units are capable of producing temperatures for aging up to 600° F.

Like every user of instruments, the compounder had requests for instruments that would be capable of taking care of requests for higher temperatures than the standard units were capable of producing. We, therefore, had to do some searching and produce a unit which would meet these requests and comply with temperatures as high as 1000° F. This necessitated the substitution of stainless steel for aluminum since the aluminum that was being used for the purpose melted at a temperature of 1200° F.

For the evaluation of the plastic quality of unvulcanized elastomers in a raw as well as a compounded state, we had been furnishing our Model NBS Mooney viscometer, and up until 1948, 212° F. seemed a satisfactory temperature for this evaluation. More recently, however, new materials were discovered which required greater heat to fabricate. The Mooney viscometer, in order to give the proper assistance to the compounder, had to be adapted to fit the purpose. Temperatures of up to 350° became "normal" in many instances, and the original instrument, as it was designed, left much to be desired. We, as an instrument manufacturer, foreseeing this requirement, had to develop a completely new design which would be capable not only of producing temperatures up to 400° F., but also would operate over periods of time at that temperature, without undue deterioration of bearings and other rotating parts.

The instrument industry is one which produces a relatively small quantity of units. We try at all times to anticipate the requirements of the compounder. Frequently, however, we meet ourselves coming around a corner when we start searching for materials that would be suitable for inclusion in our instruments.

One case in point: we were recently asked to produce a pressure chamber which would be suitable for the maintenance of an atmosphere deteriorating to rubber, but would also have a flexible seal which would not need replacement when operated at high temperatures. The usual sources of supply that we looked to for this type of material were exactly the ones asking us to produce the instrument for evaluating it. As stated previously, the quantity of components required in this case was so small that it was not worth producing them because of the excessively high cost.

In the above, I have dealt with temperature only. My reason for doing this is that you are very familiar with the conventional tensile strength tester, its advantages and its problems, and I expect in the question period to follow to cover the details of this apparatus.

Plastics and Insulated Wire

By John T. Blake

Simplex Wire & Cable Co., Cambridge, Mass.

THE most common physical tests for plastics are those of tensile strength and elongation. There are problems in connection with plastics that are not so important in the testing of rubber. One of them is the difficulty of getting a good grip on the sample in the jaws of the tension machine. This is particularly true of the harder plastics, or samples that have been subjected to accelerated aging, or samples which have been immersed in oil possibly at elevated temperatures and for long periods of time. Samples of plastic insulation prepared by removing the conductor from a small insulated wire must be tested as a tube, presenting a similar problem.

One method we have developed for overcoming some of these troubles is to cover the parallel type of tensile jaws with a soft, wax-free, vulcanized natural rubber. Fragile samples are gripped gently but firmly. These jaws are better also for samples which tend to neck down.

Another method we have used is to wrap the test sample with an abrasive-covered paper or cloth at the place where the jaws grip the samples. This tends to distribute the jaw pressure and reduces slipping. It does not overcome the trouble with samples which neck down when stretched.

These devices are makeshifts which have allowed us to get more satisfactory tests than can be obtained by conventional methods. Possibly the makers of test equipment could be of real help to industrial laboratories by supplying special jaws for tasks that now trouble us.

The testing of some of the newer rigid and semi-rigid plastics poses problems in setting suitable standards and interpreting the test results. As an illustration, the newer types of crystalline polyethylenes give results that differ greatly, depending on the rate of stretching. One material, when tested at a rate of 20 inches per minute, gives an ultimate tensile strength of nearly 4500 psi. The elongation results are of an entirely different order of magnitude. At 20 inches per minute this same material gives an ultimate elongation of 20-30% but at 0.2-inch per minute the elongation is 400%.

One can ask readily which of these values is the one we want as a control and can ask also the relation of this twentyfold variation in elongation to service conditions. How can we discriminate between materials for a particular service?

As a side issue, testing at 0.2-inch per minute is intolerably slow and naturally decreases the productivity of a laboratory.

There is another related problem that we call notch or nick sensitivity. Some of the new rigid and semi-rigid plastics may fail if there is a nick, cut, or notch in the surface, and the sample is bent. This type of failure can occur when an insulated wire sample is bent to a degree that might be met during manufacture and installation of cables. It provides a problem both in obtaining consistent tests and relating the test method to service conditions. Obviously, the type of nick or notch, its depth, and the rate of application of the stress, as well as the degree of strain, produce widely varying results.

Some of the newer crystalline polyethylenes are subject to so-called heat shock.

Samples of material extruded on wire and then wrapped around its own diameter may crack completely at temperatures of about 110 to 120° C. This sort of test was used in the early days of polyvinyl chloride insulations and was a measure of inherent strains. In the case of PVC, the usefulness of this test has disappeared, but now it is an important test for some of the newer materials.

The standard ASTM heat distortion test, when used for ordinary grades of polyethylene, is misleading to people not familiar with this particular test procedure. This is a test in which a beam sample is supported four inches apart and subjected to a load applied in the middle of the beam. The load is adjusted to produce a definite fiber stress, and the temperature is raised until a distortion of 10 mils occurs. For standard high-pressure polyethylenes a distortion temperature of 122° F. is produced, and this low value has at times in the past scared potential users. Probably a new method relating more closely to service conditions should be evolved if the name of this test is to be retained.

For years abrasion tests on rubber samples have been made in the laboratory, and, although it is recognized that they must be supplemented by road testing, in the case of tires, they have been useful tools for development. Similar abrasion tests on plastics give results much more difficult to relate to service conditions. Plastics are being used more and more in situations where abrasion resistance is an important property. Probably work should be done on laboratory abrasion tests that will be of greater utility.

The irradiation of polyethylene is producing materials which have attractive and interesting properties. It may be that special tests will be required to appraise these materials in terms of service.

Fabrics

By John H. Dillon

Textile Research Institute, Princeton, N. J.

PROBABLY one of the greatest advances in textile testing techniques during the past ten years has been made by the application of statistical theory to the planning and interpretation of experiments. One will find even in the modest control laboratory of a small mill a good understanding of statistics and, therefore, an appreciation of the significance of the few tests that are made. This is heartening for it indicates real progress. But what of the ultimate meaning of the test results in terms of product performance? I'll venture that 75% of all fabric testing in this country today is done with no real concern for quantitative correlation or even pseudo-quantitative ranking of test results with product performance.

Now this attitude is understandable and, in a sense, justified. First of all, attaching meaningful numbers to fabric performance is very difficult, especially in the apparel field where consumer subjectiveness is hard to evaluate. Secondly, it is rather gratifying to be able to control the quality of a given type of fabric within narrow statistical limits by applying some arbitrary strength test and thus avoiding rejects, purely on the basis of blind qualitative experience. Indeed, this is an accomplishment from the standpoint of the "as is" world.

But the tester of fabrics, or of anything else, should also be thinking about the "as we'd like it" world, and that means not just controlled, but improved products. Improved products are difficult to achieve through smugly precise qualitative control testing. They come naturally by quantitative extension of physical test data obtained on the constantly changing products of chemist and engineer.

Now just a few significant examples: Load-strain tests come first to mind because of the frequency of their use. They are also probably important because they can provide numbers to describe effects ranging from degradation by heat to deterioration caused by the attack of carpet beetles and cockroaches. Like all mechanical tests in textile materials, they must be performed under controlled humidity, and it is well to have a reasonably constant temperature also. The newer hydrophobic fibers are, of course, not so sensitive to humidity as are cotton, wool, rayon, and acetate. Nevertheless one must not be misled by a regain of 4% or less; sometimes a small change in moisture in a hydrophobic fiber will have a profound effect on physical properties.

I don't propose to engage in a controversy concerning constant rate of traverse *vs.* constant rate of loading. Most of the existing pendulum and incline plane testers are capable of accurate, useful results, if properly operated with an understanding of their basic mechanical limitations. For the greater precision and versatility required in a research laboratory, however, a variable-speed, inertia-free strain-gage type of tester is desirable. I suggest that a simplified strain-gage instrument will become commonplace in routine control testing laboratories in not too many years, simply because it can be used for so many purposes. For example, it can be employed as a very sensitive thickness gage.

The conventional load-extension testing of fabrics is a pretty crude business, of course, regardless of the type of testing machine employed. Measuring breaking load, either in the warp or fill directions, or both, seldom has any sensible bearing on the service conditions of the fabric. Measuring the load-extension function in warp and fill directions simultaneously, with each initially orthogonal set of yarns reacting on the other, is not very difficult, and the resulting realistic load-extension curves only faintly resemble those obtained by conventional uni-axial tests. Yet the conventional "grab" or "cut strip" uni-axial test is "so easy"—why not keep using it, whether its results have meaning in product performance or not?

It is quite refreshing to deviate from the testing of apparel fabrics to regard the strenuous efforts of people in the rubber and plastics industries. Here it seems at last that there is an appreciation of the importance of time as a parameter in elastic performance of high polymers. I'm not sure that there is yet universal agreement on a tire cord fatigue test, but it seems at a glance that fatigue contraptions are a little more scientifically sensible than they used to be. I must admit that long ago I participated in the design of a marvelous cord fatigue tester. It was wonderful for cotton cords, but, when high-tenacity rayon came along and then nylon, it was even more successful. It fell apart in its violent efforts to rupture these brave fibers in continuous filament form. Perhaps if we had more examples of outmoded devices and techniques actually falling apart, we would be further along in the quest for more revealing physical tests for fabrics.

Tire Compounds

By John W. Liska

The Firestone Tire & Rubber Co., Akron, O.

PHYSICAL testing of tire compounds can be conveniently broken down into four broad classifications: first, control testing; second, testing to determine optimum vulcanization state; third, processing tests; and, finally, testing for compound development.

It is probably safe to say that reasonably satisfactory tests for control and optimum cure state are well known and used daily; hence, in the interest of brevity no discussion of these aspects of the subject will be undertaken. In the brief time available on this panel discussion it is obviously impossible to discuss the third and fourth classifications in any great detail. At best, only a very short summary can be given.

With respect to processing tests, it would seem that plasticity and tack determinations are the most important. Laboratory plasticity tests have been improved, over the past several years, to the point where it can be said that they are nearly adequate for most tire compound applications. Despite continuing efforts to devise a "tack" tester, however, the laboratory measurement of building tack continues to be more or less unsatisfactory. More fundamental studies of this important quality appear in order.

In the fourth category are included all of the tests such as cutting, cut growth, cracking, fatigue, ozone, aging, abrasion, and tearing resistance. Since a complete discussion of all of these is obviously impossible, I propose to concentrate my remarks on those tests which seem to be furthest from a satisfactory solution at the present time.

Ideally, it would be highly desirable to quote some formulae which would enable the technical man to specify the exact number and types of compound tests required for a particular application, precisely how these tests should be run, and, finally, how the test results should be interpreted and evaluated in terms of expected tire service or tire lifetime. Unfortunately, such formulae simply do not exist today. Although some new specific tests have been devised in recent years, and some of the older ones

have been improved, translation of laboratory compound test data into anticipated tire performance results is still more of an art than a science.

For a number of years the tests employed for compound development were essentially the same as those used for control or processing tests, and it must be admitted that some very real gains in tire performance were made as a result of the use of the old standbys, "tensile, aging, and simple flex test procedures." Continually increasing service performance requirements, however, have literally forced the development and use of new test procedures for compound development. Among these, it is believed that a test for the evaluation of the dynamic properties of tire compounds is one of the most important. Many of the recent gains in tire performance must be credited to the use of some type of dynamic test. The importance of evaluating modulus and hysteresis or heat build-up under dynamic conditions cannot be over-emphasized.

We have learned, too, that we must distinguish between heat build-up measured under constant stress conditions and heat build-up measured under constant strain conditions. Unfortunately, a tire does not operate strictly under either one or the other of these laboratory conditions, and so far no one has hazarded more than a good "guesstimate" as to the relative weights which must be applied to heat build-up under constant stress and constant strain conditions, for the tire as a whole.

Furthermore, it is quite generally accepted by now that different weightings of these parameters must be assigned to the different compounds used in the body, tread, and sidewall of a tire. The appropriate weightings of constant stress and constant strain test results which must be used for the different tire compounds are even less understood than those for the tire as a whole. Consequently one can only suggest that this phase of testing must be studied more intensively in the future.

Increasingly severe service conditions are also requiring that more attention be paid to testing at elevated temperatures in order to predict more accurately tire performance at elevated temperatures.

No discussion of physical testing of tire compounds would be complete without some reference to abrasion testing. A number of laboratory abrasion machines have been devised over the past few decades, but it is believed none has been found completely satisfactory for predicting with high precision abrasion or wear resistance of a tire under service conditions.

The reason for this lack of agreement is not too difficult to understand; nevertheless, this does not make it easier to design or devise laboratory tests which will agree better with service tests. It is becoming more and more unlikely that the problem can or will be solved by the empirical approach which has characterized most of the abrasion machines of the past. The best approach to a good laboratory abrasion test now appears to be through a thorough analysis of the complex abrasion processes into a number of decisive properties (which, when combined, produce abrasion) followed by accurate measurement or evaluation of these separate properties and finally incorporation of these separate measures into an appropriately weighted, single index of abrasion.

Tear resistance is another important characteristic of a tire compound which has proved difficult to evaluate in the laboratory. Tearing, like abrasion, is a complex process, and though the measurement of tear resistance has yielded somewhat more completely to the empirical approach than abrasion resistance, it is believed that a more complete understanding of this subject, too, will be realized only as the result of the type of approach discussed a few moments ago under abrasion resistance.

In summarizing, it can be concluded that for the most part reasonably satisfactory test procedures are now available for use in selecting tire compounds for specific end-uses, with a few notable exceptions. It is believed that more attention will have to be focused on dynamic testing and compound evaluation at elevated temperatures. In addition, it would appear that good laboratory tests for abrasion and tear resistance will come only as a result of fundamental studies of the nature of these processes leading up to mathematically weighted quality indices for these two characteristics.

Mechanical Goods

By Sherman R. Doner

Raybestos-Manhattan, Inc., Passaic, N. J.

THE mechanical rubber goods division of the rubber industry is that segment devoted to the manufacture of all products which do not fall into the classification of tires, druggists sundries, wire, and footwear.

In other words, mechanical rubber goods comprise hose, belting, molded parts, extruded goods, lathe-cut goods, etc. Our segment consumed about 20% of the total natural and synthetic rubbers used in the United States in 1955.

As you can see, we are a relatively small segment of the total rubber business in terms of rubber consumed, but we have perhaps more than our full share of problems. Hundred of thousands of items fall into the category of mechanical rubber goods, and each presents its own design, production, and testing problems.

Since this symposium is on the testing of rubber, I will confine my remarks to a few specific items.

Hose, for instance, is produced in sizes ranging from ⅛-inch I.D. to more than three feet in inside diameter. Automotive hydraulic brake hose is a ⅛-inch hose made with a synthetic rubber tube and two braids of cotton yarn with a neoprene cover for good weather resistance and is either lead-press or wrap cured. This hose is made to comply with the requirements of SAE[1] specification 40R-1, which requires that the hose have a minimum bursting strength of 5,000 psi. Its expansion under pressure shall not exceed 0.56-cc. at 1,000 psi. and 0.67-cc. at 1,500 psi. for a 10-inch length. It must flex on the "whip test" machine for a minimum of 35 hours.

This whip test consists of flexing a 15½-inch length of hose by holding one end stationary while the other end is rotated in an eight-inch diameter circle at 800 rpm. During this test the hose is under 225 to 250 pounds' hydraulic pressure.

The test method contains this statement: "The flexing motion imparted by the test apparatus, while different from that to which the assembly is subjected in service, provides a highly accelerated method of measuring the resistance of a hose to dynamic fatigue."

The hose must be so constructed and coupled that a pull of not less than 325 pounds is required to pull off the coupling. This hose must also meet a –40° F. freeze test.

The control testing of this product requires constant testing, but the proof of its value lies in the fact that one seldom hears of a brake-hose failure on an automobile. ASTM[2] Method D571 covers in detail the brake-hose testing procedure.

Hydraulic brake cups, used as seals in the master and wheel cylinders of automobiles, are truly precision molded rubber parts; the dimensional tolerances must be maintained within close limits, and the cups must remain dimensionally stable after a simulated service stroking test of 100,000 cycles at 1,000 pounds' pressure at 250° F. Brake cups were formerly made of natural rubber. Now all heavy-duty cups and many moderate-duty cups are made from styrene-butadiene rubber (SBR).[3] Minimum quality requirements are established by the SAE-60R-2 specification.

The purchasers of hydraulic brake cups without exception have specifications based on the SAE specification, but with closer limits in some respects. The reason for this policy is to insure them that they are purchasing a product which will consistently meet the SAE requirements.

The SAE specifications for brake hose, brake cups, and brake fluids have been adopted by several states as minimum requirements for safety reasons; some of these states require approval of a product before it can be sold within its boundaries, and the trend is definitely toward more of this type of safety legislation.

In addition to the above two, there are countless other automotive rubber items made from rubber, such as motor mounts, bumpers, weatherstripping, dynamic and static seals, coolant, heater, and power steering hose, to mention a few.

Many of these items are specified by the use of SAE-ASTM specification D735,[4] which, as we know, is a convenient and flexible classification of rubber materials. Special tests such as compression set, immersion in various fluids, load deflection, flex resistance, weather aging, etc., can be included by the use of suffix letters.

D735 has been a great help to both the automotive user and his rubber supplier in that it gives us a common language.

A discussion on mechanical rubber goods would not be complete without mentioning belting. Belting is one of the items respon-

[1] Society of Automotive Engineers, 29 W. 39th St., New York, N. Y.
[2] American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.
[3] ASTM D 1418-56T.
[4] "ASTM Standards on Rubber Products, May 1956," p. 370.

sible for the use of more textiles than any other branch of our business. Belting can be roughly divided into two classes, flat belting and V-belts.

Flat belting covers conveyor, elevator, power transmission, etc. Flat power-transmission belting is rapidly becoming an obsolete product. The use of conveyor belting is expanding. It is taking the place of the familiar mine trains in many coal mines, and belts are being used to transport every conceivable type of item or material, including *homo sapiens*.

Formerly the textile reinforcement of belting was cotton, but today rayon, nylon, Dacron,[5] and every other type of available strength member is being used, or at least tested.

Until less than 10 years ago conveyor belts were designed and rated strictly from theoretical figures. We now have several large belt dynamometers in our industry, and on the basis of data obtained under simulated running conditions, we are able to evaluate better the factors controlling the performance of conveyor belts. In recent years new speed and load factors have been published which indicate that in past years conveyor belt ratings were definitely on the conservative side.

Specialty Rubbers

By W. Newlin Keen

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

THE shortcomings of natural rubber, such as poor resistance to some oils and solvents, lead to the development of specialty elastomers. Once the chemist demonstrated that elastomeric materials could be made having specific properties, the design engineer has continued to put increasing demands on rubber-like products.

So today we have Thiokol,[6] polysulfide rubber, neoprenes, nitriles, butyls, silicones, Hypalon,[5] urethanes, Poly FBA,[7] Kel-F,[8] and still others that are in the field evaluation stage. From this group of materials the rubber technologist can design vulcanizates that excel vulcanizates of natural rubber in resistance to oils, solvents, chemicals, natural aging, ozone, abrasion, low temperatures, or high temperatures.

With the advent of these elastomers and with the design and application engineer stating the environment in which these materials should operate, test methods had to be modified, refined, and, in some cases, designed.

Let us consider the tests more or less in chronological order. In characterizing vulcanizates of these specialty elastomers as to their tensile strength, ultimate elongation, tear resistance, resiliency, heat build-up, compression set, flex resistance, and electrical properties, conventional test methods sufficed. The development of the oil and solvent resistant elastomers brought about modifications in ASTM D471, Immersion Test for Elastomeric Vulcanizates. In testing compounds for such applications as gaskets, tank linings, and hose tubes where the oil or solvent comes in contact with only one side of the product, a test designed to bring only one side of the test specimen into contact with the test fluid helps in selecting the best composition.

Prior to 1940 there was very little low-temperature testing primarily because vulcanizates of natural rubber met the requirements of the day. Today, as you all know, it is commonplace to be testing at –65° F. and lower in developing composition to meet many specifications.

With the specialty elastomers in general behaving differently from natural rubber at low temperatures and with the exacting requirements stipulated by the engineer, ASTM Committee D-11 has the following group of low-temperature tests:[4] D736, Thiokol-Bent Loop Test; D746, Brittleness by Impact; D797, Firestone Young's Modulus; D1043, Clash-Berg Torsional Stiffness; D1053, Gehman Torsional Stiffness; D1229, Low-Temperature Compression Set; D1329, Low-Temperature Retraction.

In some aeronautical and automotive applications, specialty elastomeric parts selected on the basis of just hardness and simple load-deflection characteristics were put into field tests, but did not perform satisfactorily. The development of dynamic testing equipment revealed the fact that the relation between the static and the dynamic modulus of most specialty elastomers was quite different from that of natural rubber. Thus we have a free vibration tester, the Yerzley oscillograph (ASTM D945), and forced vibration testers such as the Goodyear unit, Firestone unit, the Buick machine, the Lord Mfg. Co. dynamic modulus tester, and others. All of these units are so designed that they may be operated over a broad temperature range.

Another characteristic of these new elastomers noted in field testing was strain relaxation or creep. Different types of creep tests were designed, most of them straining the vulcanizate in shear. Chief among the several factors having an important effect on creep are amount and type of strain and temperature. It has been established that the higher the initial strain, the higher the creep, and the higher the temperature, the higher the creep. Creep is greater under tension strain than under equal shear strain, and it is greater under shear strain than under equal compression strain. Creep is also greater under dynamic loading than under static loading.

In part, as a result of the specialty elastomers differing from natural rubber under dynamic conditions, interest grew in learning more about the low-strain portion of the stress-strain curve. What was its true shape? Such instruments as the Instron,[9] the Accr-O-Meter,[10] and others with strain-gage weighing systems helped answer this question. These instruments also afforded the rubber technologist for the first time a means of testing at constant rate of strain.

Along with the development of the new elastomers and diversified applications of elastomeric materials, particularly in the automotive and aeronautical fields, much work was done and is being done toward improving ozone testing chambers. ASTM D470 describes the procedure for testing the ozone resistance of wire and cable compounds. In addition, ASTM D1149 describes a test chamber and gives a procedure for determining the ozone concentration. Some investigators of ozone believe that you do not know how much ozone you generate unless pure oxygen is supplied to the ozonator.

In testing specialty elastomers designed specifically for high-temperature applications, problems were encountered when oven-aging tests were conducted. The solution to the contamination problem was found in the test-tube method of aging, and the difficulties with temperature control at 300° F. and up were eliminated by the electrically heated aluminum blocks.

In addition to learning how well the vulcanizates withstand the effects of high temperature, it is becoming more and more important to know their physical properties at these high temperatures.

Supplementing these physical tests are simulated service tests. These tests are intended to duplicate the effects of the actual service conditions encountered by the product being evaluated. The devices used subject the products to controlled conditions until recognizable failure occurs. These conditions, however, are adjusted to produce failure sooner than the time required in actual use.

Questions and Answers

Q. Approximately what percentage of capital outlay should be invested in testing equipment, and what portion of personnel for testing?

A. J. T. Blake. If we omit that part of the expenditure for testing which is used to service research and development, the answer to this question can be reduced to a problem in economics.

Testing is required to insure the production of salable and serviceable goods. The ultimate in testing demands the detection of all off-grade products before they get into the hands of the customers. Such a program would involve much equipment, a large staff, and the testing of perhaps 100% of the goods produced. Depending upon the product and the necessary tests, considerable product might need to be destroyed in testing. Of course, 100% can never be used for some articles, such as shotgun shells.

At the other end of the scale we have the situation in which there is no testing of the product either in process or after it is finished. In this case some defective product is sure to get into the hands of customers with consequent money loss for returned goods and the imponderable loss of goodwill.

Somewhere between these two extremes is an optimum economic condition. This amount of testing will minimize the cost of testing plus the cost of returned goods plus the cost of lost goodwill. The first

[5] E. I. du Pont de Nemours & Co., Inc., trade mark.
[6] Thiokol Chemical Corp., trade mark.
[7] Minnesota Mining & Mfg. Co. trade mark.
[8] M. W. Kellogg Co. trade mark.
[9] Instron Engineering Corp., Quincy, Mass.
[10] Scott Testers, Inc., Providence, R. I.

increment of money spent for test equipment and people to do the testing may be expected to bring a large return in savings. These savings will take the form of prevented spoilage in process, off-grade material caught before shipment, reduction of returned goods, and maintenance of goodwill. The next increment of money spent on test equipment and personnel will bring a smaller return from the same source. Sooner or later the point will be reached where the savings resulting from additional money spent on testing will be as small as or smaller than the cost of additional money spent on testing. This point is where expenditures on test equipment and test personnel should be cut off.

The amount of test equipment and the number of people required may be estimated on this basis for each rubber product, and this will vary considerably with the type of product. For example, rubber toys might require very little testing as compared with a rubber tire, or garden hose relatively little compared to electrical insulation.

In general, the greater the number of critical properties specified by the customer or required by his type of service, the more money the manufacturer must spend on testing if he is to make certain of producing a satisfactory product.

It is not possible to answer this question without striking a balance of the economic factors in some such manner, and, of course, there is no one answer applicable to all the varied types of rubber products.

Q. What can be done or is being done to standardize and calibrate test equipment throughout the rubber industry?

A. D. C. Scott. There is a Task Group under L. V. Cooper's Physical Testing Committee in ASTM Committee D-11 on Rubber engaged in studying this particular problem. As yet, their findings have not been reported. Here again, as a manufacturer of test equipment, I would like to indicate that this is a matter of economics. We are attempting to establish a calibration service to the industry through solicitation and the travel of a trained technician to the areas where apparatus of our manufacture is located. The procedure is meeting with some success, but it is expensive, and we find that many members of industry are not interested in making the expenditure for such service when it is offered. I believe other manufacturers of test equipment would concur with me in this finding.

Q. What is the spread in values for tensile and elongation that can be expected between laboratories when testing (1) slabs; (2) finished products?

A. Scott. Answering what spread in values of any test could be expected necessitates asking another question for clarification, since what tolerance is desired is the real question. By this I mean that if a tolerance of plus or minus 20% is permissible, the minimum of care both in preparing the specimen and in evaluating it, as well as the minimum number of tests, will probably permit control within the tolerance. However, if a tolerance of plus or minus 2% or 3% is desired, extreme care must be taken throughout the testing procedure, and a greater number of tests must be made in order to determine if the material is within specification.

In testing rubber we have a number of processes through which the material must pass. To begin with, we have the pigments, the storage conditions of which have every influence upon their blending, the influence of their blending; the milling procedure, whether the nip is close and the bank high; the control of the temperature of the rolls during milling; the number of cuts made, the extent to which these cuts are made, and the time that the material is on the mill. Next, there are the control of temperature upon the press platens; the trueness of the parallelism between these platens; the condition of the mold both as to parallelism of mold and cover plate; smoothness of cavity and cover plate; the bulk of the sample introduced into the cavity for molding; the speed with which the platens bring the mold to a closure; how the sample is removed from the mold; how it is cured after removal; the temperatures under which it is cured; the keeness of edge and stable dimensions of the sample cutting die; the method of dieing even before we get to the tensile tester itself.

In this connection we have proved that good housekeeping requires at least a yearly check on the tensile tester for calibration, compensation for wear, etc. The control of all of these points must be stated before a spread in tensile and elongation values can be considered. An article in the literature indicates that on a single compound, over a period of four months a tolerance of 5% on slabs could be maintained. The normal condition, however, for the former Rubber Reserve Government laboratories in which optimum conditions of control were maintained as to equipment, personnel instruction, and standardization of procedure indicated a tolerance of 15% on tensile and elongation as good as could be reached on laboratory prepared slabs.

As far as the tolerance that can be expected on finished products is concerned, again, one would have to know more about the type of product involved, because of the variations of sample preparation procedure that would be experienced.

Q. From the buyer's standpoint are humidity corrections extremely important in fabric tensile tests? Does change in humidity have more effect on warp than on fill?

A. J. H. Dillon. In respect to the first part of this question, let us assume that the "buyer" referred to is the purchaser of the fabric to be manufactured into some product, i.e., he is not the ultimate consumer. Ordinarily, fabrics of hydrophilic fibers such as cotton, viscose rayon, and wool are tested in a controlled atmosphere of 65% relative humidity (R.H.) and 70° F., after bringing them to moisture equilibrium from the dry side; no correction is made to bring the results to a standard regain basis, as is customarily done with yarns and cords.

If the fabric is purchased on a weight basis, as is usually true for tire fabric, it is highly important for the buyer to know how much water he is paying for and what the inherent tensile properties of the tire yarns are under both bone-dry and standard regain conditions. This point is probably true also for nylon cord fabrics, even though the regain at 65% R.H. and 70° F. is only about 4%. Obviously, regain corrections become much less important for the extremely hydrophobic fibers such as Dacron.

In regard to the relative effects of humidity changes on the warp and filling of woven fabric, there is no unique answer to this question. Humidity effects on the load-extension properties of fabrics result not only from changes in the tensile properties of the constituent fibers, but also from changes in yarn configuration due to diametrical swelling. Hence variation in fabric weave, twist and size of warp and filling yarns, weaving tension, etc., will determine the relative effects of humidity changes in the warp and fill directions.

Q. What is the reproducibility of tensile strength figures at 212, 250, 275° F., as compared with 70° F?

A. J. W. Liska. Based on the extremely limited amount of data available, it appears that the reproducibility of tensile strength figures (expressed in %) is virtually independent of test temperature over the range of 70 to 275° F. for four common elastomers: natural rubber, cold SBR, neoprene, and butyl. This may not be true of compounds based on other elastomers, but not enough data are available from which any further positive conclusions can be reached.

Q. Have any improvements been made in the design of grips for the stress-strain testing of pure gum rubber vulcanizates? The present ones cause a tearing action to develop during the test, with erratic tensile strengths resulting.

A. Scott. The best answer I can give to this is that if the original equipment supplied by the manufacturer is not satisfactory, most manufacturers will be interested in hearing about it. In this particular connection, we have at least eight different types of grips for rubber dumbbell test pieces, one or two of which seem to meet the general requirements and, therefore, are suggested by us when quoting on an instrument. If, however, such shortcomings in the equipment supplied were pointed out to the manufacturer, it is possible that similar complaints have been received, and the situation improved through subsequent developments. To be sure, a special-purpose clamp frequently is not so convenient or so quick in its operation, but if it is more satisfactory for a special purpose, its use is desirable.

A direct answer to this question would be for the party who asked this question to solicit the cooperation of the manufacturer of the instrument he is using.

Q. What accelerated weathering tests on rubber are the most reliable indication of performance in service? What degree of correlation can be expected?

A. Blake. Temperature and sunlight and air, contaminants such as moisture, oxygen, and ozone influence the deterioration of elastomers on outdoor exposure. Ozone is perhaps the most important of these.

Our laboratories seem to find good rela-

tive correlation between the estimated service life and results from the "Ozone Weatherometer." The initial work in this correlation study was based on the use of the well-known Crabtree and Kemp apparatus.[11] The test is reproducible and accurate for comparing the relative resistance of samples to ozone degradation. The test does arrange a series of samples in an order which parallels their deterioration under a given set of weathering conditions. There seems to be no real accuracy as yet in estimating the actual service life of a compound by the test since, obviously, no two service conditions are the same.

Instruments which accelerate aging of elastomers by exposing them to cycles of light, humidity, ozone, and temperature do not seem to give so good a correlation between this type of testing and outdoor weathering.

A. S. H. Doner. The Geer oven and oxygen bomb tests are the most commonly used accelerated aging tests. We know that these two tests provide valuable information regarding the aging properties of a rubber compound, but they do not simulate all of the conditions found in natural aging.

In recent years much work has been done on ozone testing, using 25 and 50 parts of ozone per hundred million parts of air in temperature controlled test chambers. The results apparently closely approximate those obtained by long-time natural aging, and round-robin tests conducted in several laboratories yielded good correlation. ASTM D 1149-55T describes the method, but it is strictly tentative at this time.

Q. What is the present status of ozone testing—dynamic and static?

A. W. N. Keen. The ASTM subcommittee coping with the problem of ozone testing has arrived at the fact that the lack of correlation from laboratory is due largely to insufficient rate of flow of the ozonized atmosphere into the test chamber, and insufficient agitation within the chamber. A unit designed to overcome these shortcomings is currently being made. It is understood that a round-robin test is now in progress to determine how these new units correlate from laboratory to laboratory.

At least seven different devices are being used for dynamic tests in an ozone chamber. In general, these devices are designed to operate on a cycle of flex, rest, flex, in order to approach service conditions. One of these units is unique in that it is air operated and produces a two-dimensional strain on the test specimen, prepared from a standard 6- by 6- by 0.075-inch slab.

One of the flexers put into an ozone chamber is identical with a unit used outdoors to study the effects of atmospheric conditions on vulcanizates being flexed slowly. It will be interesting to learn whether or not some correlation between these two units can be established.

Q. Are there any good viscometers on the market which will measure viscosity at various rates of shear and temperature? If not, why is this type of testing device so difficult to design?

A. Scott. I would prefer to answer the second question first. It is not difficult to design an instrument, but it is extremely difficult to find a market, the sales to which will compensate you for the work involved in producing an instrument which you might design.

Speaking for the Mooney viscometer, the Model NBS[10] was established at one rate of shear and with temperature variations commensurable with the needs of the industry at the time it was designed. Recently developments within the industry have indicated a decided demand for increased test temperatures and to some degree a variation in shear rates. Our new Model STI[12] Mooney viscometer incorporates the ability to produce elevated temperatures with excellent control and further permits the variation of temperatures for the evaluation of the samples.

We have given some thought to a variation in the shear rate. To date, however, we have been unable to consolidate sufficient information from the industry that will permit us to give any serious consideration to what rates of speed are desired. This feature, however, has been considered in the design of the new Model STI, and as soon as we can find out what is desired, we anticipate developments in that direction.

Other viscometers offered to industries in general incorporate variations in speed as well as temperature. They are not, however, suitable for the evaluation of elastomeric materials.

Q. Can Williams plastometer readings be correlated to factory processing, and how is Mooney viscosity being used as a batch-by-batch control of processability?

A. Blake. The three more widely used plasticity tests—Firestone, Mooney,[12] and Williams[13]—do not predict accurately the performance of *new* compounds in factory processing. In compound development such tests are valuable in the preliminary adjusting of rubber compounds, after which they must be modified by actual factory trials.

For *accepted* factory compounds, all these plasticity methods serve as a useful control. Any major change in plasticity reflects a change in the compound which might affect processing. Such changes would not necessarily be indicated by other tests, such as physicals on cured slabs.

Since all of the plasticity test give values which do not compare entirely with factory results, the selection of the type of test used is dictated partly by its convenience and the speed of testing. We use the Firestone plasticity for production control. Being an extrusion method it gives fairly close correlation with actual factory extrusion conditions. Because the test is made with a positive displacement under controlled pressure, sometimes it gives no indication of the action of the stock in the barrel of the factory extruder. The Firestone plastometer is simple and versatile, and the conditions of the test can be varied widely to accommodate compounds of an extreme range of plasticities.

The Mooney viscosity test is probably more widely used than either the Firestone or the Williams. In the Mooney test the plasticity or viscosity is evaluated by a shearing action caused by motion of a rotor in the center of the test piece. From a standpoint of production control it is a good test since satisfactory control readings can be taken from 1½ to four minutes after the machine has started. Sample preparation is simple, but the acquisition of results requires more attention on the part of the operator than does the Firestone test. Readings must be taken while the machine is running and at specified times. The Mooney apparatus is less versatile than the Firestone in that fewer adjustments can be made to the machine to extend its range. It does give values usable for control work on all normally used compounds. It can be used conveniently to indicate scorchiness in compounds.[14]

The Williams test has to a large extent been supplanted by the Mooney test, but the Williams test is valuable for the measurement of nerve of elastomers.

All three tests measure somewhat different properties in the uncured stock so that data from one test cannot be converted readily to one of the others. This condition often leaves the choice of test to personal preference based on operating convenience rather than on factual information obtained from it. For convenience of operation either the Firestone or the Mooney is preferred since neither requires an accurately sized sample. Williams nerve values are important in extruding shapes to close tolerances. It is also useful for embossed calendering.

A. Keen. Williams plasticity and recovery readings can be and have been correlated to factory processing. The plasticity number is a good indication of the flowability of the material which may be related to extruding, calendering, or molding. The recovery figure is a good indication of how the material will change in dimensions upon extrusion or calendering. Although, in general, the Mooney viscometer has replaced the Williams plastometer, the latter instrument is still being used as a factory control test in the processing of cements.

A Mooney viscosity curve obtained at a scorch temperature is very useful as a batch-to-batch control of processability. Processability is used here in the full sense of the word, that is, as related to extruding, calendering, or flow during molding. The viscosity during the first two to three minutes reflects the viscosity of the raw polymer and gives some indication of how well the compound has been mixed.

The time to incipient vulcanization indicates whether or not all the curing agents have been added. The most popular scorch temperature for natural rubber is about 275° F., and 300° F. for SBR.

Q. Discuss single-strand static adhesion test for bead wire.

A. L. V. Cooper. Two of the properties required of bead wire are (a) some adhesion when built into the tire and (b) resistance to rusting in storage. Materials used to inhibit rusting often cover up the coating on the wire which gives the required adhesion—hence the laboratory adhesion tests on incoming shipments.

[11] *Rubber Chem. Tech.*, 20, 808 (1947).
[12] ASTM D 927-55T.
[13] ASTM D 926-47T.
[14] ASTM D 1077-55T.

Q. Compare the better methods for evaluating the degree of pigment dispersion in a rubber compound.

A. Blake. Proper dispersion of pigments in rubber is important from many standpoints, and it is a complicated problem. Physical and electrical properties and processing characteristics are dependent upon adequate dispersion. Theoretically, the evaluation of the dispersion should take into account the properties desired most in the final product by the pigment addition.

One method is the measurement or estimation of reflected light from a freshly cut rubber surface. Poorly dispersed particles in the surface scatter the incident light and reduce the intensity of the reflected light.

If physical properties are used as a measure of the effect of different mixing methods, one must use a number of samples to compensate for normal variations. Valuable physical tests are tensile and tear. Even these can be misleading unless care is taken to interpret results in the light of what is desired from a service standpoint. Physical tests, in general, are not sensitive enough to measure differences in dispersion beyond a certain degree of homogeneity.

It has been shown, for instance, that by using a laboratory Banbury mixer to incorporate carbon black in SBR no improvement in physical properties was obtained after about four minutes' mixing, but that the electrical resistance continued to rise up to eight minutes or more. This rise in electrical resistance shows that the carbon black aggregates were still being broken up. The measurement of electrical resistance in carbon black stocks is a sensitive measurement of dispersion.

Another method is to measure transmitted light through extremely dilute solutions (0.01% or less) of rubber mixture in solvents. The method depends upon the pigment particles being small enough to remain suspended in the solvent. Poorly dispersed aggregates too large to remain suspended settle to the bottom and will not affect light transmission.

All of these methods serve particular purposes. In general, nothing can take the place of the microscope in determining the quality of a dispersion. It is relatively simple to view a freshly cut surface under the microscope and count or estimate the number of undispersed particles and to compare the results with those on a dispersion known to be satisfactory.

Q. When lab testing tread compounds, what are the most reliable methods for (a) crack initiation, and (b) cut growth?

A. Liska. Although much effort has been spent on the development of a laboratory tread-cracking test for both crack initiation and cut growth, some form of one of the earliest ones developed, the DeMattia test,[15] appears to be both the most widely used and the most reliable. Other types, such as the Firestone groove cracking machine and modifications of a molded-groove belt test, are also used in various laboratories with varying degrees of reliability, but none seems to be so widely accepted as the basic DeMattia method.

(To be continued)

[15]ASTM D 813-52T.

Philadelphia Hears Gehman In Gamma Radiation Talk

"Gamma Radiation and the Rubber Industry" was the subject of a talk given by S. D. Gehman, The Goodyear Tire & Rubber Co., Akron, O., before 132 members and guests of the Philadelphia Rubber Group at the Poor Richard Club, Philadelphia, Pa., January 25.

The Goodyear researcher pointed out that gamma rays interact only with the electronic structures of atoms, not with the nuclei, so that chemical and physical effects occur without inducing radioactivity. Cs 137 and Co 60 were cited as the best isotope sources for gamma radiation.

The effects of high-intensity gamma radiation of most interest for the rubber industry arise from the way the energy is dissipated in organic compounds to result in chemical reactions. A new field in polymerization research has therefore opened, since radiation can do things which cannot be done by the usual chemical means.

Dr. Gehman thought radiation graft polymers especially interesting. The effects on solid polymers are complex, and depending upon the structure, cross-linking or degradation may predominate. Most types of raw rubber can be cross-linked or vulcanized without the assistance of heat or chemicals, he declared, although the radiation dose required is large. The physical properties of some plastics can also be favorably affected by radiation.

In the business session preceding the talk, Aaron Back, American Foam Latex, described the course in basic rubber technology to be given at Villanova University in cooperation with the Philadelphia Rubber Group. The course will be conducted on a graduate level. Mr. Back will be the instructor.

Newly elected officers of the Group were announced as follows: chairman, J. R. Mills, Goodall Rubber Co.; vice chairman, R. A. Garrett, Armstrong Cork Co.; secretary-treasurer, R. S. Graff, E. I. du Pont de Nemours & Co., Inc., and directors, H. M. Sellers, Lee Tire & Rubber Co., and G. N. McNamara, Pequanoc Rubber Co.

Garvey Talk in Washington

"Effects Produced in Natural and Synthetic Rubber by the Use of Accelerators" was the title of a talk given by B. S. Garvey, Jr., Sharples Chemicals Division, Pennsylvania Salt Mfg. Co., before 50 members and guests of the Washington Rubber Group at the Pepco Auditorium, Washington, D. C., February 13.

Dr. Garvey pointed out that with the increased rate of processing of rubber it has been necessary to process rubber at higher temperatures, making scorch an ever-increasing problem. Compounders must adjust conditions so that scorching is prevented until the material is placed into a mold for curing. He reviewed the accelerators which have been developed for delaying action, thus allowing higher processing temperatures without scorching.

Talk on Rigid Polyethylene Is Given at Fort Wayne

James Roach, Phillips Chemical Co., addressed 152 members and guests of the Fort Wayne Rubber & Plastics Group at the Van Orman Hotel, Fort Wayne, Ind., February 7, on "Marlex-50 Polyethylene —Properties and Applications for the Most Rigid Polyethylene."

The areas of application for the rigid polyethylenes are those in which high-softening temperatures, increased rigidity, toughness, strength, and chemical resistance are important. Among the applications which are most promising for Marlex-50 polyethylene and other similar rigid and semi-rigid ethylene polymers is in the use of these materials in unsupported film. Mr. Roach showed slides of this film to support his contention.

The plastics industry was said to be particularly interested in the application of Marlex-50 as monofilaments and fibers, pictures filament, fabrics and ropes. The chief disadvantage of the high-pressure polyethylene here was its comparatively low softening temperatures and tendency toward tackiness when hot. Oriented Marlex-50 resin filaments exhibit tensile strengths from 50,000 to 150,000 psi.

Mr. Roach described such other applications as industrial structural materials, equipment parts, wire and cable covering, tubing and pipe, houseware items, and bottles, again using slides.

Marlex-50 can also be blended with rubber compounds to produce end-products having unusual and useful properties. The polyethylene has been blended with SBR, SBR cold-rubber gum stocks, SBR cold-rubber tire tread stocks, SBR cold-rubber stocks containing mineral fillers, butyl rubber tube stocks, and SBR cold-rubber black stocks.

These blends may be processed satisfactorily with standard roll mill or Banbury equipment at temperatures of 270-300° F. A final cold remill yields more pliable uncured stock and also improves the properties of the vulcanized stock. The cold remill results in lower heat build-up, lower hardness, and improved impermeability. Compounds containing ten or more parts of Marlex-50 may require an increase in extrusion temperatures to permit satisfactory rates and good appearance.

Corrections

In our November, 1956, issue, page 265, BL-353, a blowing agent for expanded rubber made by E. I. du Pont de Nemours & Co., Inc., was incorrectly identified as a product of Imperial Chemical Industries, Ltd., London, England; Harwick Standard Chemical Co., Akron, O., American distributor.

The identification should have been for Vulcacel BN, an ICI product.

In our February, 1956, issue, page 725, Antioxidant 2246 was incorrectly identified as a product of Monsanto Chemical Co. Antioxidant 2246 is the trade mark of an American Cyanamid Co. product.

NEWS of the MONTH

Washington Report and National News Summary

. . . Vinson Bill would sell alcohol-butadiene plant at Louisville, Ky., as soon as possible, limited only to future production of some 70 strategic chemicals.

. . . Solicitation of public bids on Akron Government Laboratory and Pilot Plant delayed, but disposal decision by May is likely.

. . . General Services Administration postpones indefinitely any meeting with its Rubber Industry Advisory Committee for consideration of plan for freeing more natural rubber from strategic stockpile in view of Suez Canal closing.

. . . World rubber industry outlook appears related, however, to European economic activity, which is influenced by Suez Canal situation.

. . . National Science Foundation reports $890,000 spent on high polymer research for year ending June 30, 1956. NSF-sponsored high polymer research conference being considered.

. . . Worldwide distribution of new international natural rubber standards backed by 24 producing, packing, and consuming organizations in 13 countries begun by Rubber Manufacturers Association. U. S. A. imports for 1955 show drop in quality.

. . . RMA urges rubber industry opposition to Patman-Kefauver amendment to Robinson-Patman Act which would limit manufacturers' ability to reduce prices to some customers to meet competition.

. . . New Goodyear-URWA labor contract signed.

Washington Report

By ROBERT E. L. ADAMSON

Vinson Bill Would Sell Louisville Butadiene Plant; Only Restriction, Strategic Chemical Production

The House of Representatives and its Committee on Armed Services decided in February that the alcohol butadiene plant at Louisville, Ky., is no longer needed in the program to keep enough synthetic rubber capacity available to meet a possible emergency. Sent to the Senate for consideration by its Banking and Currency Committee and, subsequently, by the Senate itself, was the Vinson bill to permit sale of the plant for manufacture of one or more of some 70 chemicals important to the mobilization base.

Prompt Disposal Asked

Furthermore, the "rush" label was attached by powerful representative Carl Vinson of Georgia, the bill's author and chairman of the House Armed Services Committee. When RUBBER WORLD went to press, the outlook for speedy action by the Senate Banking Committee was not good, but the Administration was planning steps to jog the Committee into early consideration and approval to allow completion of the disposal program before Congress adjourns in mid-summer.

Publicker Industries of Philadelphia, present operator of the plant under lease and unsuccessful bidder twice in 1956 to take over the facility for a long-term or outright purchase, was reportedly working behind the scenes on Capitol Hill to block approval of a sale before its lease expires in April of next year. With the powerful opposition of Publicker, the question of time gained particular importance in the eyes of the disposal agent, Federal Facilities Corp., and Vinson and others in the House who want the plant sold this year. In its report to the House, submitted by Vinson, the Armed Services Committee had this to say:

"It is the unanimous opinion of the Committee on Armed Services that the proposed legislation, as amended, should be enacted in the best interests of the government and in the best interests of national defense. Prompt action will enhance the price to be received and undoubtedly will stimulate greater interest from among potential bidders."

In a word, the Committee was highly annoyed by government expenditure of $342,000 annually in maintenance and taxes while the plant is in its present inoperative state. Along with Federal Facilities Administrator Laurence B. Robbins, the Committee does not want the government to stand another year's expense of this size while Publicker's lease expires.

On the other hand, Publicker has a real commercial interest in the facility and argues further that the plant's capability to produce butadiene is necessary to the country's mobilization position—notwithstanding the recent advice from the Office of Defense Mobilization that Louisville could be released from the requirement that it be available for butadiene production for 10 years after sale.

Enough Butadiene

The Vinson Committee, however, pointed out that the alcohol-butadiene plant at Kobuta, Pa., sold to Koppers Co., Inc., in 1955, has never operated and is available under the sales contract until 1965 for emergency production of alcohol butadiene for national defense purposes

in the amount of 80,000 short tons annually.

"Furthermore," the Committee emphasized, "reports to the Federal Facilities Corp. show that national petroleum-butadiene capacity rated at 621,000 short tons at the end of 1955, would be increased by an additional 416,000 short tons during 1957 and early 1958. This total of 1,037,000 short tons exceeds 1959 estimated annual requirements of butadiene for synthetic rubber and all other purposes by 146,164 short tons.

"In this connection, the Committee has been advised that expansions and construction of new plants, using butane as a starting feedstock for the production of butadiene, have been undertaken by the following companies: Petro-Tex Chemical Corp., Houston, Tex.; Firestone Tire & Rubber Co., Orange, Tex.; Odessa Butadiene Co., Odessa, Tex.; and Texas Butadiene & Chemical Co., Houston, Tex.

"The Administrator of the FFC stated that any possibility of an assured economically successful operation of the plant in the future as an alcohol-butadiene facility is far too unlikely to warrant serious consideration, in the light of the petroleum butadiene supply picture and the recent operating history of the plant, and further stated that under existing law, the plant could not be re-offered for sale until after April, 1958, when it would be expected to be turned over to the General Services Administration for disposal under that agency's established procedures.

"A prompt sale, under new legislation which would not restrict the use of the plant to the manufacture of alcohol-butadiene and containing an appropriate national security clause, (is) recommended as the best method of disposal.

"It is the opinion of the Committee that the plant should be sold, and that this should be done now. The committee is convinced that it is unrealistic to expect continuous commercial operation of this facility for the production of alcohol-butadiene, which inevitably must compete with butadiene produced from petroleum.

"Because the basic raw material for petroleum-butadiene is cheaper per pound of product than alcohol, petroleum-butadiene can be produced and sold at a price appreciably below that which alcohol-butadiene must command in order to yield a profit. Thus, alcohol-butadiene is not price-competitive with petroleum-butadiene. Alcohol-butadiene labors not only under the competitive disadvantage of an important price differential, it also faces great expansion from its petroleum-based competitors. . . .

"Therefore, with the economics of the industry in mind, the committee is of the opinion that any requirement that a buyer intends to operate the plant for the production of alcohol-butadiene is not realistic and should not apply to any sale of this plant."

Broad Security Clause

All previous rubber facility disposals have been made subject to a 10-year national security clause requiring the purchaser to maintain the plant in readiness to produce synthetic rubber or a component for the first decade of private operation. Such a clause was carefully inserted in the Vinson bill, but its scope was broadened to include any chemical important to the national security—an expandable list ranging from acetic acid to toluene and covering almost 70 commodities. Basically, it is the "great expansion" of petroleum-butadiene capacity that has led government spokesmen to decide that the alcohol-butadiene plant at Louisville is no longer a national defense contributor.

"Much of this new capacity," the Committee explained, "will utilize butane as raw material; butane is a natural gas which is in plentiful supply. Thus the production base for petroleum butadiene is being broadened. With the increased use of butane as a feedstock, the petroleum butadiene industry will become more flexible and better able to withstand a possible future siphoning off of butylenes (for aviation gasoline). As the jet age progresses, more and more military aircraft are being powered by jet fuel which does not require butylenes. . . .

"It is the belief of the Committee that a broadened national security clause would increase bidding interest in the plant and make a higher sales price more attainable. The national security clause will be an effective bar to any cannibalization of the plant. It must be maintained as part of our broad industrial security base, but, since the importance of alcohol-butadiene has diminished, it is sound policy to permit the plant to be converted and maintained for the production of one or more other chemicals important to the national security."

Strategic Chemicals Involved

The Vinson bill was explicit on just what chemicals it is designed to cover: (1) any one or more chemicals for which production goals were established under the Defense Production Act of 1950, as amended, during the calendar years 1951 to 1955, inclusive [68 are on this list now]; (2) a chemical or chemicals for the production of which a material has been determined to be strategic and critical under the Strategic and Critical Materials Stockpiling Act of 1947; or (3) any other chemical or chemicals not presently included in the first two categories which the President may approve as important to the national defense, either upon request from the FFC prior to the entry into a contract of sale or upon the request of the purchaser during the term of the national security clause.

"Thus," the Committee pointed out, "the proposed legislation authorizes the FFC to sell the Louisville plant in basically the same fashion as the Rubber Producing Facilities Disposal Commission earlier sold synthetic rubber facilities under the original disposal Act of 1953 and amendments thereto.

"Disposal is to be made subject to the existing lease, thus safeguarding the position of the present lessee [Publicker]. The proposed legislation authorizes the receipt of proposals, and subsequent negotiations on the basis of the proposals received, leading to a contract of sale. Any proposed contract of sale must be submitted to the Congress for review, and is subject to disapproval by either House. The Attorney General must furnish advice on the sale . . . as to whether it would tend to create or maintain a situation inconsistent with the anti-trust laws."

With time of the essence so far as the Administration and the Armed Services unit were concerned, government officials close to the proposed program were alive to the possibility of a Senate amendment to preclude Congressional review, since the Vinson bill would take the plant out of the rubber program. This tack would virtually guarantee sale this year.

Disposal Decision in May Now Seen for Akron Labs

The General Services Administration, running into slight delays in disposing of the government's rubber research laboratories-pilot plant at Akron, still expects the final decision on disposal to come in April or May. Advertised bid invitations to the general public were tentatively slated to go into a dozen of the nation's newspapers late in January, but appraisal of the property for the government's own files delayed the advertisements at least a month.

GSA put the appraisers to work—under government contract—to come with a "fair market value" of an up-to-date nature which the agency feels is necessary to consider non-government bids when they come in some time in late March or early April. Like everything else in a disposal portfolio at this stage, the contractor's appraisal is a top secret.

Agriculture Retains Interest

But enough is known about the Akron file to make an "educated guess," backed up by off-the-cuff comments of GSA spokesman, that private industry will be bidding against the Agricultural Department for the right to take over the Akron facilities. Of the 20-odd responses GSA had to its survey of Federal Government interest in the property, the Agriculture Department was the "most interesting" in terms of dollar-replacement value to the government.

Under the disposal law approved by Congress last summer, GSA had to ask all government agencies with a possible interest to assess the property for feasible utilization by the government and, if any interest was there, to estimate what price the government should get from a private purchaser to make the sale economically worthwhile. Secretary of Agriculture Ezra Taft Benson, whose department was responsible for this unique disposal procedure, came back with the best "bid." His department could use the laboratories in its research program to find new uses for surplus farm products and, therefore, suggested it was worth a certain amount to the government.

If non-government bids coming in this month and next top Benson's figure, the Bureau of the Budget, which has the final say in the matter, would naturally lean

toward disposal and assign the funds to Agriculture for construction of laboratories designed for food research. If the best private offers do not match or exceed the farm research value, it is doubtful that Budget could legally or practically order a transfer to private hands. This much is sure—whatever Budget decides will not be subject to review by Congress as has been the case in the disposal of most of the plants erected as part of the synthetic rubber program of World War II.

Government vs. Industry Bids

GSA will weigh the private offers against its appraised "fair market value" and probably negotiate the good offers to get them a little higher. Bid opening and subsequent negotiations, if there are any, will be handled by GSA's regional office at Chicago, the office nearest the property itself. By mid-April the agency will have a definite or near-definite idea of what the plant is worth to the most interested non-government interests. When it has what it considers the best possible offer, it will turn the Akron portfolio over to the Budget Bureau for this watchdog agency's decision on whether the facilities should be sold or retained.

In either case the government cannot lose. If it sells, the proceeds will go to build modern laboratory facilities at little or no cash outlay from the U. S. treasury. If it retains title, the property will probably go into other use or into standby status until a more favorable time to sell.

GSA Industry Committee Stockpile Meeting Killed, World Rubber Industry Outlook Hinges on Europe?

GSA in February cancelled a tentatively scheduled meeting of its Rubber Industry Advisory Committee and thereby buried the possibility of receiving a rubber manufacturers' plan for emergency supply of government-stockpiled rubber—at least unless or until an unforeseen crisis develops.

Stockpile Meeting Cancelled

In retrospect, the Administration's handling of the problem—under the leadership of Arthur S. Flemming, Director of Defense Mobilization—was a masterpiece of prognostication. After weeks of argument over the pros and cons of making government rubber available in an emergency, if necessary, Dr. Flemming ordered a rejection of the proposal subject to later consideration if delayed deliveries from the Far East threatened to create shortages harmful to the national interest.

Within a month, the pressure for government intervention had weakened considerably as shortages failed to develop, and the domestic market gained in resiliency. A member of the government's special inter-agency committee on rubber summed up the situation as it stood last month:

"It looks like the Government made a very sensible decision. With the price situation what it is, the pressure is not there now for a change in the rotation system."

A GSA spokesman said the decision to cancel a meeting of the Industry Advisory Committee, indefinitely, was based on the quiet prevailing in the industry. A meeting for January had been scheduled to take another look at the ill-fated stockpile proposal, but that was postponed until February or March. With the Suez Canal stop-up bringing no crisis in the domestic market, GSA decided to forget about the meeting altogether, or until it has some other reason to get the Committee together.

"We don't have any pressing rubber problems or any recommendations from industry, so we haven't scheduled any meeting for them," the GSA official explained.

In connection with effect of the Suez shutdown on rubber movements, the Commerce Department's Business & Defense Services Administration ran a check on shipments through the Panama Canal after Suez was closed to shipping early in November. They found an "unusually large" movement of rubber eastbound through the Panama ditch during November, indicating that quite a number of United States purchasers of Far Eastern rubber had switched their shipments to vessels moving eastbound from the Far East rather than westbound via South Africa. But this picture was apparently only temporary, because their study of December rubber movement through Panama showed up "normal," indicating that purchasers had reverted to form and scheduled rubber cargoes on the vessels moving around the Cape of Good Hope.

Varied Consumption Estimates

Commerce Department officials also reported that January was a surprisingly good month for rubber consumption, despite the turndown in Europe because gasoline rationing there has brought a cutback by the motor vehicle industry and reduced use of automobiles. Nevertheless, the Department's experts envision 1957 as another record year for U. S. exports of synthetic rubber, although they cannot hazard a guess at this time on how much 1957 might exceed the record 112,000 tons of styrene-butadiene (SBR) rubber exported in 1956. This view is at variance with February predictions of H. C. Bugbee, president of the Natural Rubber Bureau, who said synthetic rubber demand outside the U. S. in 1957 would run about the same as last year—295,000 tons.

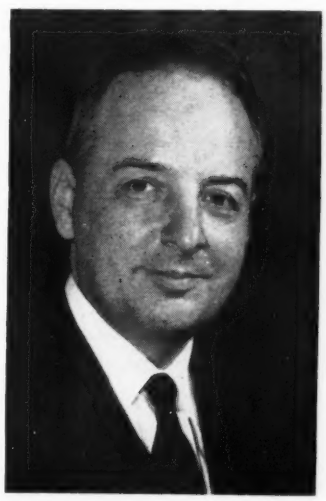
Some 112,000 tons of this would be produced in Canada, 13,000 tons in Germany, and 10,000 in new plants elsewhere in Europe, he estimated, leaving demand for U. S. rubber at about the 1956 export figure—160,000 tons of synthetic of all types. From these figures, Mr. Bugbee said, "we conclude there is limited scope for increasing this year U. S. synthetic exports over the 1956 rate of 160,000 tons."

Mr. Bugbee also forecast total domestic consumption of all new rubber at 1,500,000 tons this year, including 930,000 tons of synthetic and 570,000 tons of natural.

"If this materializes, and stocks of synthetic in the U. S. are stabilized at approximately 200,000 tons," he explained, "then the rate of synthetic production which ruled for 1956—1,080,000 tons—could be maintained for 1957. Any lowering of the 1,500,000 consumption figure, however, will necessarily be reflected not only in natural, but in synthetic and will involve either a cutback in synthetic production or a further build-up of synthetic stocks."

Commerce Department experts conceded that "at the moment the Suez crisis is retarding European rubber consumption," but insisted the international picture on rubber supply and demand "would indicate a steady growth in synthetic consumption." There "is still a most likely prospect that U. S. exports will exceed 1956," they added.

Thus, the world rubber outlook for the rest of the year is hinged very heavily on revival of the European economy to full tempo by the restoration of normal transportation facilities for Middle East oil. Barring severe political dislocations of the schedule, government and industry officials who should know were predicting the Suez Canal would be cleared by May 12, and full tanker movement through it would be restored shortly thereafter. As to the trans-Syrian pipeline from Iraq—capacity 500,000 barrels of oil daily—it was virtually impossible to predict when it could be restored in view of Syria's unsympathetic attitude.



Arthur S. Flemming

ODM Director Flemming Resigns

Arthur S. Flemming, Director of Defense Mobilization under the Eisenhower Administration, has been replaced after four years of service by Gordon Gray, former Secretary of the Army under President Truman. Dr. Flemming returns to his pre-government post as president of Ohio Wesleyan University.

As Defense Mobilizer, he made many decisions, during his long tenure, of vital

interest to the rubber industry, including his action last December in shelving a rubber manufacturers' proposal for a standby plan to change the stockpile rotation system if necessary to meet shortages stemming from the Middle East crisis.

Dr. Flemming also resisted earlier pressure, during 1955, to reduce the stockpile itself; he had—and turns over to Mr. Gray—full control of the huge government inventory of natural rubber. The Defense Mobilizer also has final authority over the program to encourage construction of production plants for strategic commodities by issuing certificates for rapid tax write-offs on the cost of construction. The portion of the program covering butadiene was closed by Dr. Flemming and has been under restudy for the past year.

1956 NSF Polymer Research Spending $0.9 Million; NSF Suggesting High Polymer Research Conference

The National Science Foundation, carrying the ball on synthetic rubber research since taking over from FFC on July 1, 1955, reported in February that it awarded 11 contracts worth $890,000 in its first year—fiscal year 1956 ending last June 30. With applied research on synthetic rubber now left entirely to private industry, all of the fiscal 1956 grants and those during the current and future fiscal periods will be restricted to basic research, with emphasis on high polymers.

As recalled in NSF's sixth annual report to Congress—fiscal year 1956—a special Advisory Panel for High Polymer Research advised the government last year to move away from synthetic rubber research into the more basic area of high polymers. Out of the panel's review and recommendations came a variety of research grants by NSF during the current fiscal year ending June 30. During fiscal 1958, NSF will continue this support for high polymer research "as an integral part" of its chemistry program.

NSF Polymer Research

In reporting to Congress on the first year of its responsibility for rubber research, NSF said the largest contract for basic research in synthetic rubber went to the National Bureau of Standards—$194,000. Others were awarded to: University of Akron, former operator of the Akron rubber laboratories of the government, $45,000; Burke Research Co., $150,000; Case Institute of Technology, $40,000; University of Chicago, $37,000; Cornell University (two), $51,000 and $10,000; University of Illinois, $107,000; Massachusetts Institute of Technology, $98,000; Mellon Institute of Industrial Research, $84,000; and University of Minnesota, $74,000. More than the total of these was spent during the final year of operation at the Akron laboratory-pilot plant, which is now in mothballs—$950,000.

NSF Polymer Conference?

Key men at the Foundation are also agitating for a conference on high polymer research of the type sponsored by NSF from time to time in other areas of science. These meetings provide a forum for the exchange of information and ideas among scientists who are pioneering in new or incompletely explored fields. They also furnish opportunity in many cases for younger scientists to learn and obtain advice from some of the world's outstanding senior scientists. To insure wide distribution of conference subject matter, proceedings and papers are frequently published by the sponsors. Normally the request for NSF support of conferences originates with scientists working in the field under review, but the scheduling of a high polymer conference is already being endorsed within the Foundation itself.

Research Training Needs

NSF's sixth annual report included a warning by the agency's director, Alan T. Waterman, that the Federal Government may not be doing enough to guarantee maximum concentration on research and scientific training. His agency's support for basic research in college, he noted, provides advanced research training for more graduate students.

"To the increased need for basic research and the training of scientists," he warned, "we must add the urgent need for general research equipment to supplement and replace the obsolete equipment now in use. For that matter, there is a great need to renovate research facilities of all kinds at colleges and universities. Even more extensive is the need for equipment for instructional purposes, both for laboratory and demonstration use—a need felt in all colleges, but probably most acutely in the secondary schools. Better laboratories and scientific equipment would prove a great asset for recruiting desperately needed science teachers in the elementary and secondary schools.

"Perhaps the most critical question is: Can these widespread needs of science in our educational institutions be met adequately and quickly in the customary way by local support, from state, municipal or private sources? Indeed, our national welfare depends in considerable degree upon the promptness and thoroughness with which we can assure the maintenance of a strong scientific research effort and an adequate supply of trained scientific manpower.

"A major consideration is the degree to which the Federal Government should participate in the solution of these most urgent problems. The most important goal is to create an awareness and an understanding on the part of our citizens regarding the fundamental and critical nature of these problems, in order that speedy progress may be made toward their solution."

Research Spending

The report also contained some interesting figures on actual research spending —compiled, the Foundation explained, because "amounts, kinds and costs of scientific research must be known when agencies and organizations plan programs and develop policies for research and development." Down to 1955, the Foundation said, rough assumptions were widespread that total expenditures for scientific research-development in the United States were between $3 billion and $3.5 billion annually. Based on statements from 10,000 business enterprises, and on estimates of costs of research conducted by educational institutions, government agencies, and other types of research organizations—all cooperating in a survey sponsored by NSF—U. S. expenditures for all research-development for the year 1953 were not $3.5 billion, but well over $5 billion.

Of this total, private industry alone expended $3.7 billion, of which $1.4 billion, or 35%, represented work done for the Federal Government. Although private industry's contribution to the support of basic research was reported as nearly $150 million, this represented only 4% of the total expenditure by private industry in 1953 for all research-development.

National News

Natural Rubber International Standards Issued; U.S.A. Import Survey Shows 1955 Quality Drop

Backed by 24 producing, packing and consuming organizations in 13 countries, The Rubber Manufacturers Association, Inc., began, on February 11, worldwide distribution of a new set of natural rubber standards aimed at vastly improving the quality of many grades of this raw material moved in international trade.

International Standards Booklet

These standards are published in a booklet entitled, "Type Descriptions and Packing Specifications for Natural Rubber Grades Used in International Trade," and

embrace the 36 grades of rubber which account for the bulk of international trade in dry rubber. The new document supplants the RMA "Type Descriptions and Packing Specifications for Natural Rubber," which with modifications from time to time have stood since 1928 as the world's most widely accepted set of standards for world trade in the 30 RMA grades which it covered. Included in the new standards are the 30 RMA grades and six new grades referred to as the Singapore types.

In the new book, 24 of the previously designated RMA types which now have the full endorsement of all the world associations concerned have been redesignated as "International Types." The remaining 12 types in the new publication are the six RMA grades and six Singapore grades which now overlap to some degree. W. J. Sears, chairman of the RMA crude rubber committee, stated that all endorsing organizations have agreed to work toward the elimination of the overlapping grades with the objective of ultimately including them in Part II of the book of internationally agreed single standards.

Mr. Sears expressed his belief that this agreement by all organizations for the first time to produce, grade, pack, and ship rubber against a single set of uniform standards will do much to improve the quality of natural rubber imports into this and other consuming countries. The substandard quality of imports has plagued consumers since World War II.

The new standards were developed by the RMA crude rubber committee following two international conferences on rubber quality and packing, held in Singapore and New York in 1954 and 1955. Adoption of the standards was unanimously recommended by all parties to the New York Conference in 1955. This recommendation won the support of the International Rubber Study Group at its meeting in Monrovia, Liberia, later that year.

Now that these standards are available, each of the organizations that have cooperated in this undertaking must urge all their members to make full use of them, the RMA said. If these standards are to prove effective, trade and factory buyers must specify them in their purchase contracts; producers and shippers must prepare and offer their rubber in accordance with them. If the producer and packer follow these standards in preparing their rubber, there will be no difficulty from the buyer who inspects the delivery against the same set of standards, it was added.

Import Survey

In order to determine the extent of the delivery in the United States of off-quality, substandard natural rubber, procedures were developed to analyze statistically the quality of natural rubber imports. This program began first under government direction when it was the sole purchaser of natural rubber during the Korean War period, and when the government returned the rubber trade to private industry, the RMA and the Rubber Trade Association of New York continued this annual statistical analysis.

The data obtained are based upon inspection reports of dealers and importing manufacturers. These reports show the total tonnage imported, the total tons accepted as proper tender without any claim, and the total tonnage upon which quality claims were made, broken down into categories of ¼ grade off, ½ grade off, 1 grade off, and 2 or more grades off. The reports upon which the yearly grade analysis is made do not show the reason for the quality claim. Therefore the nonconformance reflected in these analyses is due to a combination of improper grading to RMA type samples and type descriptions, and non-conformance to RMA packing specifications.

These analyses have been made for the five consecutive years 1951 through 1955, and the report covering the year 1956 will be available later. When the study was first made covering the year 1951, it showed that only 58.4% of the imports conformed to the RMA standards. Although improvement was registered in 1952, 1953, and 1954, the study for 1955 proved to be most discouraging since the quality of the rubber fell substantially, as may be seen from the table which is given below.

A review of these U.S.A. import data for the five-year period indicates that the general level of natural rubber quality decreases as the level of natural rubber price increases, the RMA stated. The worst quality conditions have existed during periods of high natural rubber prices; while during periods of lower natural rubber prices, the quality level has been much better.

The undependable quality of natural rubber has its influence in the decisions by the rubber products manufacturer as to whether to use natural or synthetic rubber for a given requirement, it was added. The relative usage of natural and synthetic rubber depends upon many factors, including the basic technical properties of the materials and, perhaps, more importantly, the relative price. The influence of natural rubber quality is not now controlling in the manufacturer's major decisions on synthetic or natural rubber use, but it will have an accumulative effect in the years to come unless the natural rubber producing and packing industry takes the steps necessary to improve quality and uniformity of their product, the RMA pointed out.

TABLE 1. NATURAL RUBBER QUALITY IMPORT SURVEY—1951-1955

Year	Amount * Imports Analyzed Long Tons	Conformance to RMA Standards in %			Average N. Y. Price No. 1 RSS ¢ per Lb.
		Complete	Within ¼ Grade	½ Grade or More Off	
1951	498,543	58.4	75.4	24.6	59.07*
1952	508,258	65.4	83.6	16.4	38.57*
1953	435,933	69.9	88.3	11.7	24.23
1954	411,728	71.7	87.5	12.5	23.64
1955	429,932	62.6	82.9	17.1	39.14

*U. S. Government average selling price until June 30, 1952.

RMA Opposes Robinson-Patman Act Amendment by Patman-Kefauver

The Rubber Manufacturers Association is urging the rubber industry to make its views known promptly to its Congressmen with regard to new legislation concerning the Patman-Kefauver amendment to the Robinson-Patman Act. This new legislation (H.R.-11 and S.-11) would severely limit the right of a manufacturer to meet in good faith the lower price of a competitor by lowering his price to one or more customers without necessarily having to make comparable reductions to all customers.

Advocates of the new Patman-Kefauver amendment have labeled it an "equality of opportunity" bill, a misleading title, the RMA points out, that could well obscure, in a hasty reading, the restrictive effect of certain provisions which might seriously disrupt long-established marketing practices of rubber products.

Under the current Robinson-Patman amendments to the Clayton Act it is unlawful for sellers engaged in commerce to discriminate in price between different purchasers of commodities of like grade and quality, and the Federal Trade Commission may prove violation of the Act by showing that price differentials were granted on like products to some, but not all customers by the same manufacturer in the same competitive area. Once FTC establishes such a case of price discrimination, the accused manufacturer under the existing statute, may defend his position by showing among other things that the lower price he granted to one or more, but not all of his competing customers was done "in good faith to meet an equally low price of a competitor." If this fact is established by the manufacturer, the Supreme Court has held it is an absolute defense to charges of unlawful discrimination in price.

Under the new H.R.-11 and S.-11 amendment a manufacturer could not reduce his price to one or more customers without reducing his price to all his customers. This new legislation would probably force competing manufacturers to charge all customers the same price for fear of violating the law. Price rigidity at all marketing levels would result, and manufacturers, buyers, and consumers would be deprived of the fruits of competition, the RMA said.

It was pointed out further that if our competitive economy is to be preserved, a manufacturer must be free to go into any and all markets and try to sell his products at the prevailing local price. By the same token, a manufacturer must, in order to survive, be permitted to lower his price in order to meet prices offered to one or more of his customers by a distant competitor just coming into his area.

This freedom of action, the FTC once stated, "is not only indispensable to a competitive economy, to the protection of consumers, but is an essential armament for small businessmen in their efforts to hold as well as develop their share of the market."

The RMA regards the Patman-Kefauver amendment as a dangerous threat to the rubber manufacturing industry and has in no way modified the opposition to it expressed in June, 1956, when a similar bill passed the House of Representatives, but later died in the Senate.

Goodyear-URWA Master Contract Signed; Local Union Approval Seems Assured

Agreement on a new master contract between The Goodyear Tire & Rubber Co. and the United Rubber Workers of America, AFL-CIO, covering some 24,000 hourly employes in 11 Goodyear plants, was reached in Dayton, O., on February 10, shortly before expiration of the old one.

The new contract followed 25 days of joint negotiations between the company and the union, which began on January 15; this contract runs until April 15, 1959. It is subject to the approval of the URWA's international executive board, and it must be ratified by the majority of the local unions, representing a majority of the membership. Since both parties expressed satisfaction with the new company-wide master contract, quick approval of the new agreement is anticipated.

In addition to the Goodyear plants in Akron, O., other plants covered by the new contract are located in Gadsden, Ala.; Jackson, Mich.; St. Marys, O.; Muncie, Ind.; Lincoln, Neb.; Windsor, Vt.; New Bedford, Mass.; Topeka, Kan.; North Chicago, Ill.; and Los Angeles, Calif.

Some highlights of the new agreement are a more liberal vacation program which increases the vacation time for employes with 11 years' service to three weeks, and employes with 25 years' service to four weeks. Also, three are provisions for standardizing paid lunch periods, increased payments for night bonus to at least 6¢ an hour, and makeup pay for employes up to a maximum of two weeks per year who are required to enter upon active training duty as members of a reserve component of the Armed Forces.

It was announced on February 21 that the Akron Goodyear URWA local union had ratified the new master contract.

Other Industry News

Fire Completely Damages Pequanoc's Butler Plant

The rubber reclaiming plant of Pequanoc Rubber Co., Butler, N. J., was completely destroyed by fire early in the morning of February 26. The loss included buildings, equipment, and material in process. The only building surviving was the adjoining power plant which suffered considerable damage, but which will be in operation shortly. This power plant also supplies the requirements of the American Hard Rubber Co. plant in Butler.

According to a statement of the company, the loss, estimated at close to $5,000,000, is completely covered by insurance on property, equipment, use, and occupancy. Plans for rebuilding the plant are now being developed and will be announced in the near future.

The company employed some 350 workers, and it was stated that every effort will be made to secure other employment for as many workers as posssible and to ease the burden of the others.

Pequanoc is constructing a new plant in Tallapoosa, Ga., for compounding, and the work on this plant will be rushed to completion as a result of the Butler plant fire.

Du Pont Shows Industrial Products Research Lab Work

The operations, aims, and achievements of E. I. du Pont de Nemours & Co.'s industrial products research laboratory, textile fibers department, were aired by company researchers and managers during an all-day press conference and tour, February 20.

Dedicated to providing a sound technical base for improvement and diversification in the industrial use of cellulosic and synthetic fibers, the $2,000,000 laboratory, established late in 1954, is located in Newport, near the company's main offices and facilities in Wilmington, Del.

The building housing the laboratory has floor space of about 40,000 square feet, including offices, physical test laboratories, and operating areas for the production and testing of industrial end-products made from rayon, acetate, nylon, orlon acrylic fiber, Dacron polyester fiber, and Teflon tetrafluorethylene fiber, which the textile fibers department produces.

The laboratory serves as the second arm of du Pont's textile and industrial products research division, carrying out major research functions in relationship with the textile fibers department's merchandising and technical service organizations, fundamental research laboratories, and manufacturing plants.

In addition to physical testing facilities for fibers and industrial end-products, the laboratory includes an operating area in which key steps in the manufacture of industrial products can be duplicated. Investigations are conducted on du Pont fibers in such applications as tire cord, plastics reinforcement, non-woven fabrics and felts, papers, bearings, coated protective coverings, filling materials, and mechanical rubber goods.

In tires research, the laboratory also employs the services of outside laboratories. An acoustics research program currently is under way at a consulting laboratory to study road-noise problems as they relate to tire cord. Extensive tire-service studies are also carried out with test fleets in Pennsylvania and Texas.

The lab's tire research is designed to complement the huge tire research programs conducted by the rubber companies and other material suppliers, such as du Pont's elastomer chemicals department, which makes neoprene and other chemical rubbers.

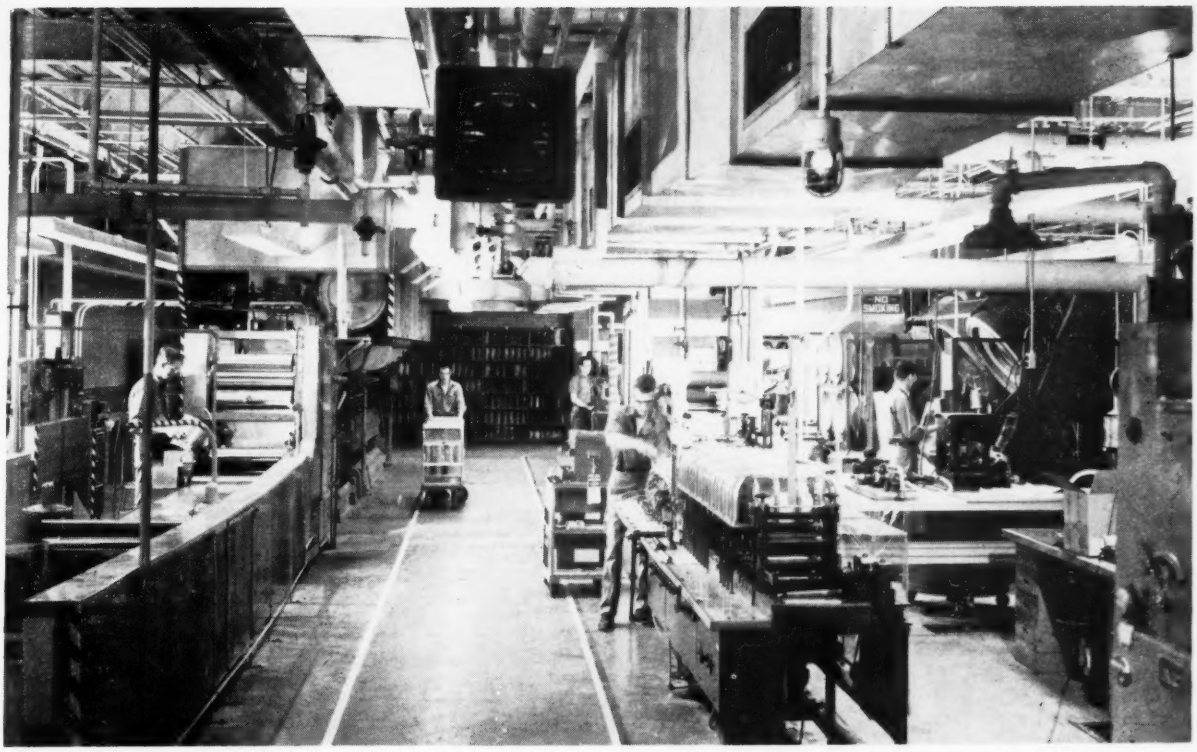
Richard W. Nebel is the director of the industrial products research laboratory, and Russell W. Peterson is research director of the textile and industrial products research division. John M. Swanson is research manager for programs on tire cord and mechanical rubber goods at the laboratory.

A report on the technical operations of the laboratory and some of the progress achieved in the two years of its existence was given in the form of six papers presented to the press gathering. The titles of the papers and their authors were the following:

"Research on Tire Cord," John M. Swanson; "Progress in Tire Cord," Donald H. Heckert; "Papers and Non-Woven Fabrics of Synthetic Fibers," Peter R. Lantos and John R. Emery; Plastics Reinforcement with Synthetic Fibers," John T. Maynard and Wilmer E. Hansen; Teflon Tetrafluoroethylene Fiber," William O. Hofmann; "Synthetic Fiber Felts," Herbert G. Lauterbach; and "Coated Nylon Protective Coverings," Robert J. Scheetz.

Robert H. Stafford, assistant manager, industrial merchandising section, textile fibers department, introducing the symposium, predicted the continuing replacement of natural fibers by synthetic fibers because their properties make them more efficient and less costly despite their higher price. He also foresaw the replacement of many wood, metal, and paper products by synthetic fibers.

Mr. Swanson, discussing the testing of tires at the industrial products research laboratory, said three general types of



In this section of the operating area of du Pont's industrial products research laboratory, a dip-stretch unit *(left)*, a miniature papermaking machine *(right foreground)*, and a commercial Bag-O-Matic press for curing tires *(right rear)* are being operated by technicians

problems were involved: the development of nylon fibers needed to realize the minimum cost differential between nylon and rayon while maintaining the durability advantages of nylon; the development of processing techniques specific to nylon; and the improvement of the "aesthetics" of nylon tires, which include the sound quality and type of ride.

Mr. Heckert said that although nylon-cord tires cost about 20% more than rayon-cord tires, the cost per 100 miles of riding for the nylon-cord tire was 7.1¢, as compared to 8.2¢ for the rayon-cord tire, in terms of the life expectancy of the tires. That was why his merchandising group was directed to stimulating a desire to build, sell, and buy nylon tires by tire and auto companies and dealers and by the consuming public.

Mr. Hofmann revealed that Teflon tetrafluoroethylene fiber, now in commercial production at du Pont, is available as continuous filament yarns and as staple fibers for use by yarn spinners. The fiber has high resistance to chemicals and heat and is slippery. It is being used to make filters for highly corrosive liquids and gases and, more importantly, as a packing material for valves in the chemical industry where they last considerably longer than ordinary packing.

Mr. Scheetz said that coated nylon protective coverings were gaining acceptance in consumer and industrial applications because of their performance advantages over treated heavy cotton-duck fabrics which dominated the field until about four years ago. Neoprene and vinyl coatings are used to provide a waterproof and durable surface. They are spread-coated from a solution and, in the case of vinyl, often laminated on to both sides of the nylon base fabric. Hypalon chlorosulfonated polyethylene is currently being tested as a coating because of its abrasion resistance and color stability.

Seal-Kap Acquires NRM Stock

American Seal-Kap Corp. of Delaware has acquired 47% of the common stock of National Rubber Machinery Co., Akron, O., supplier of machinery for the rubber and plastics industries. No change in the Akron firm's management is anticipated.

American Seal-Kap, which through its subsidiaries operates in the paper and metal fabrication fields, is expected to report a 1956 sales volume of about $20 million. National Rubber Machinery, with plants in Akron and Columbiana, O., Clifton, N. J., and a yet-to-be-opened plant in Leetonia, O., had sales of about $16 million during 1956.

N.R.C. Now Jointly Owned

Columbia-Southern Chemical Corp., Pittsburgh, Pa., and National Research Corp., Cambridge, Mass., have become associated as equal stockholders in N.R.C. Metals Corp., formerly a wholly owned subsidiary of National Research, which will produce and sell zirconium and hafnium metals to the Atomic Energy Commission and to other customers.

N.R.C. Metals currently has under construction at Santa Rosa County, near Pensacola, Fla., a plant for the production of zirconium and hafnium, which are being used as components in nuclear reactors. Zirconium metal is also said to be finding acceptance as a construction material in the chemical processing industries because of its corrosion-resistant qualities.

F-B 20-Inch Pelletizer

The largest machine in the rubber pelletizer line of Farrel-Birmingham Co., Inc., Ansonia, Conn., is being designed with a head that can be quickly opened by means of a hydraulic breech-locking device and head-opening cylinder in case of trouble from tramp metal or in case a badly mixed batch is dropped into the unit.

The design of the new head also facilitates cleaning and eliminates the possibility of scorching at the head end when accelerated stocks are being handled, according to the company. The 20-inch pelletizer is the first of a variety of screw-type machines that have been developed for the take-away and further processing of stock discharged from the Banbury mixer.

Amoco Building New Plant

An extensive research and development program aimed at creating new products for the rubber, plastic, chemical, and paint industries has been announced by the newly organized Amoco Chemicals Corp., Chicago, Ill.

The first major development project will be the construction, somewhere in the Midwest, of a plant for an "exclusive" new hydrocarbon oxidation process to produce aromatic acids from petroleum raw materials.

The company has a plant at Brownsville, Tex., which is said to be employing a unique hydrocarbon synthesis process, producing aliphatic chemicals such as ethyl alcohol, acetaldehyde, and butyl alcohol, as well as gasoline from natural gas. A second plant, at Texas City, Tex., makes aromatic hydrocarbons for resins, plasticizers, and insecticide oils.

Amoco Chemicals was formed early this year by the consolidation of Pan American Chemicals Corp., a subsidiary of The American Oil Co.; Indoil Chemical Co., a Standard Oil Co. (Indiana) subsidiary; and the former Hidalgo Chemical Co., a Stanolind Oil & Gas Co. subsidiary. The new corporation is licensed to operate throughout the United States and plans to broaden its foreign markets.

Further details of the expansion program are expected to be released at a later date.

Goodyear Aid to Education

The Goodyear Tire & Rubber Co., Akron, O., will continue its aid-to-education program through 1957, according to F. J. Carter, vice president in charge of industrial relations. The program, designed to stimulate interest in scientific careers, was first announced last year.

The program is providing for advanced technical training for full-time public and parochial high-school mathematics and science teachers in Summit County, Ohio. It is also giving financial aid to further the education of Goodyear personnel who are engaged in engineering and technical work.

A third provision is the increasing of the enrollment and facilities of the Goodyear Apprentice School and the company-sponsored engineering squadron training program.

Appointed by Woonsocket

Bertrand C. Miclette, production manager of Woonsocket Rubber & Plastics Products Co., Woonsocket, R. I., has been selected as manager of the firm, succeeding George R. Keltie, who retired from active service last October.

Other managerial posts were newly filled by Michael Storti, as general sales manager; Robert J. Reilly, as production manager; John C. Harvey, as sales manager for rubber thread; and James Barry, as cost accountant. Robert C. Ferris remains as plant superintendent, and A. J. Gobeille as assistant treasurer.



Warwick McCutcheon

Huber Akron Office

J. M. Huber Corp., New York, N. Y., will open a new sales office in Akron, O., on April 1 under the management of Warwick McCutcheon. The office will handle the sale of Huber carbon blacks, clays, and chemicals for the rubber industry in Ohio and eastern Michigan. The office will be located in the First Akron Building, 611 W. Market St.

With the opening of the Akron office, Huber representatives will call directly in all areas with the exception of the West Coast, New Jersey, and eastern Pennsylvania. These East and West Coast areas will continue to be serviced by H. M. Royal, Inc., with headquarters in Trenton, N. J., and Los Angeles, Calif.

Keener Rubber Established

Keener Rubber Co., Inc., has been established on a five-acre site at 700 Commerce Court, Alliance, O., for the production of rubber bands "of every type, size, width, and color." Kenneth B. Miller is president, with O. R. Herron, vice president in charge of sales, and Steve Bugara, vice president in charge of production. Helen Schwall is office manager. The plant currently has 30 employes. Sales representatives are now being appointed.

BFG Lists Education Aid

A total of 121 colleges and universities in 33 states has benefited from gift matching and tuition sharing grants in the aid-to-higher-education program announced last April by The B. F. Goodrich Co., Akron, O. Four-hundred-ninety employes have participated in the gift matching and tuition sharing plans.

The University of Akron received 23 gifts from Goodrich personnel, the largest number received by one school. Case Institute received 14, and Ohio State University, 11. Ohio leads the states, with 20 schools sharing in gifts.

Motorists Polled on Tires

Motorists are more concerned about tires than any other performance feature on their cars when on the road, according to a motivation research study on passenger tires conducted for E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

The motorists queried cited brakes as their next main concern, with engine trouble following. Of all possible tire problems, blowouts were considered the most important because they were closely associated with the possibility of physical injury or loss of life. Skidding was thought of in terms of property damage.

In terms of safety and strength, most car owners considered the kind of tire core more important than any other listed component, such as the thickness of rubber, kind of rubber, number of plies, or tread design. Almost all of the respondents thought that nylon was a better fiber for tire cord than rayon.

Only 15% of those questioned said they bought replacement tires because of the brand name. The survey also noted that most purchasers bought their tires in sets of two or four.

H-R Selling Tile Interests

Hewitt-Robins, Inc., Stamford, Conn., will sell its rubber and plastic floor tile manufacturing equipment and inventories to Johnson Rubber Co., Middlefield, O. The sale will be consummated on April 5. Terms of the sale were not disclosed.

Hewitt-Robins has its tile manufacturing equipment at its Fremont, O., plant, where foam rubber cushioning is also produced. The company says the sale will release additional floor space needed to expand production of other products in which the company has a more dominant market position, such as conveyor belting and machinery, industrial hose, vibrating screens, and power transmission machinery, as well as foam cushioning.

Johnson Rubber manufactures a diversified line of rubber and plastic products primarily for the automotive and heavy-appliance industries.

New Voit Board Formed

A new board of directors has been formed for W. J. Voit Rubber Corp., Los Angeles, Calif., which was recently purchased by American Machine & Foundry Co., New York, N. Y.

Willard D. Voit retains his position as president. Morehead Patterson, president of AMF, was chosen chairman of the board. Others elected to the board were Rodney C. Gott, AMF executive vice president; Robert W. Kerr, AMF vice president; D. S. Meiklejohn, AMF treasurer; and H. P. Parker, executive vice president of Voit.

The new board of directors appointed G. D. Godfrey vice president; Clarence J. Johnson assistant secretary; Mell M. Barton and T. A. Kelly, vice presidents in charge of sales; T. R. Edkins secretary; and W. H. DeSellem, treasurer.

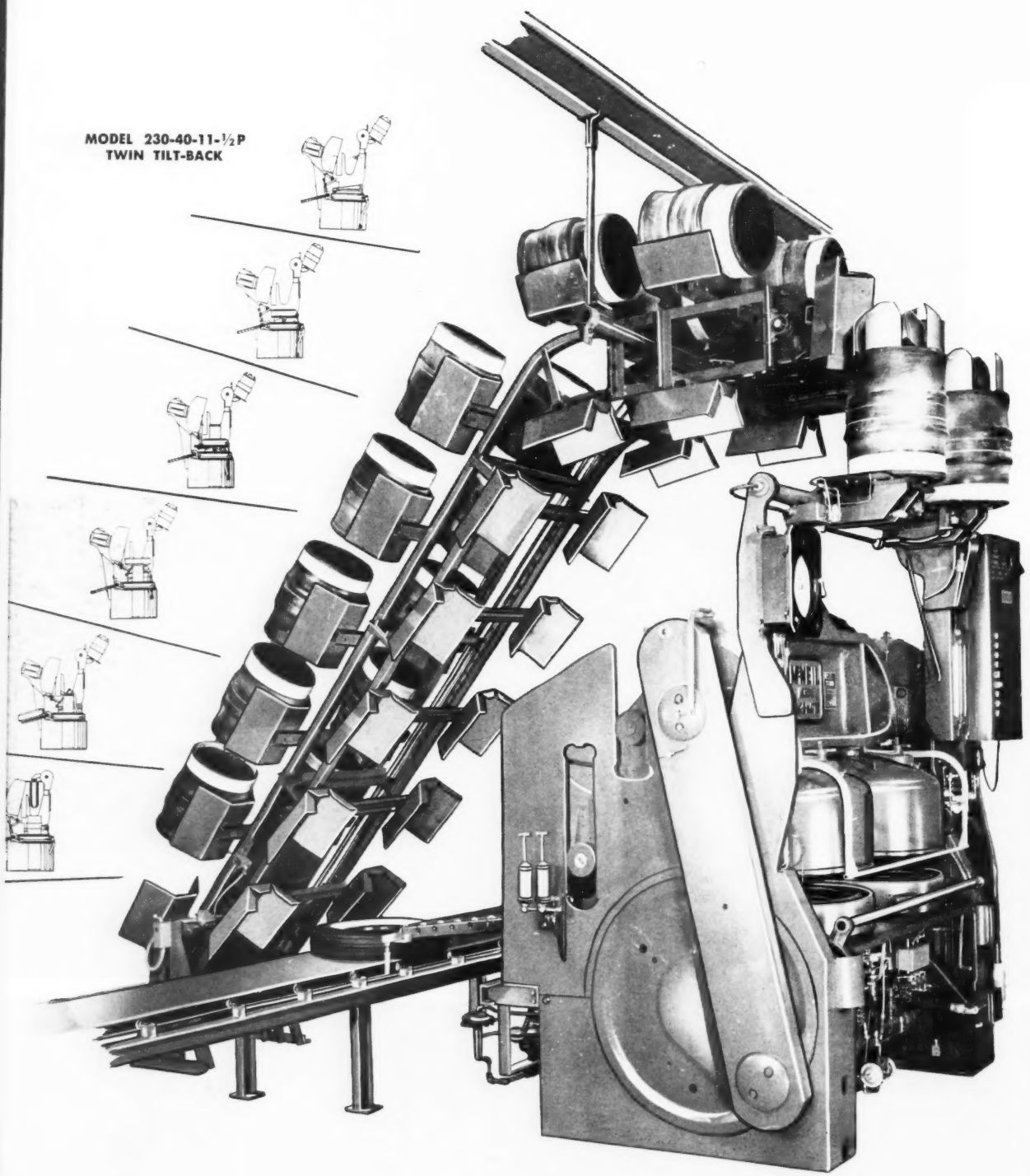


McNEIL
AKRON

proudly presents
the Rubber Industry's first completely
automatic curing press

automation in curing

FIRST with Shear Strip Tire Presses
FIRST with Bladder Type Presses . . . and now



with Completely Automatic Curing Presses

THE NEW AUTOMATIC BAG-O-MATIC

Here it is — the world's first completely automatic tire curing press: The McNEIL-AKRON Model 230-40-11-½P Twin Tilt-Back Bag-O-Matic.

It brings all of the advantages of automation to tire curing — BETTER QUALITY because all cycles and operations are always identical, free from human errors.

1. Presses need not operate in sequence. Each press is timed for the minimum cure for that particular size tire. Sequence of press openings need not be considered when mold changing is necessary.
2. Short, uniform cures are possible as the presses are open for the minimum amount of time, allowing molds and bags to stay hot.
3. Bag life becomes even greater since the bag does not cool down as much between cures. HISTORICALLY, OUR DIAPHRAGM LIFE HAS BEEN AT LEAST TWICE THAT OF COMPETITIVE BLADDER-TYPE PRESSES.
4. Automatic BAG-O-MATICS result in production increases of 10 to 15% over manually-operated installations.

In addition, this new AUTOMATIC BAG-O-MATIC has amazing versatility. It handles all passenger tires in rim diameters of 12" through 16", and will accept cross sections through the new 9.50 or 10.00 sizes.

The 40" Tilt-Back is, of course, built to unequalled, world-famous McNEIL precision and quality standards. This means that it is unsurpassed in design, engineering and production performance. It is as reliable, efficient and maintenance-free as only a McNEIL press can be. Your inquiry will be welcomed!

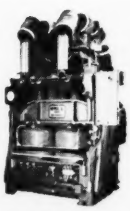
A. J. Michelson

VICE PRESIDENT IN CHARGE OF SALES

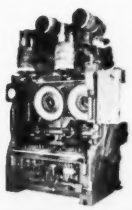
THE NAME TO REMEMBER FOR PRECISION

McNEIL AKRON

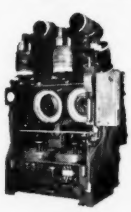
Manufacturers of the World's Finest Rubber Curing Equipment



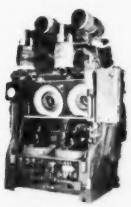
1 Press opening — tires dropping on expanding loading chucks



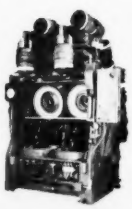
2 Press fully open — cured tires stripped from molds



3 Cured tires held horizontally —



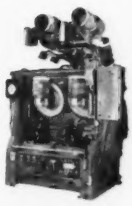
4 Lifting bar raises — tires discharged through rear of press



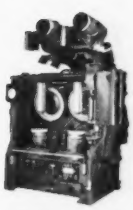
5 Tires move down rear rollers to belt conveyor



6 Rear view showing feeder conveyor



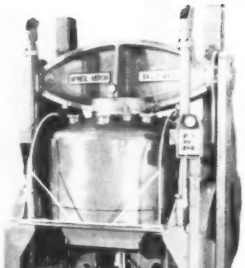
7 Press ready for automatic loading. Expanding chucks ready to drop uncured tires



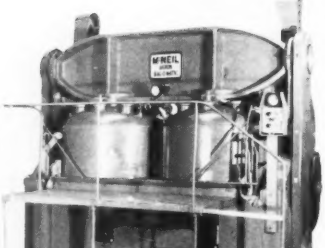
8 Uncured tires have dropped onto Bag-O-Matic bladders. Press now closes for next automatic operation

Only McNEIL makes a Practical Profit-Producing Press for every type of Tire and Mechanical Goods Production

TIRE PRESSES



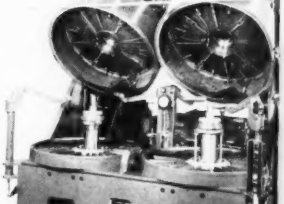
Model 900-75-25D
BAG-O-MATIC Tilt-Back



Model 450-55-16D
BAG-O-MATIC Tilt-Back



Model 275-45-10D
Twin BAG-O-MATIC



Model 300-47½-11½D
BAG-O-MATIC

MECHANICAL GOODS PRESSES



Model 800-24x48-7
Electrically
Heated Platen



Model 800-32
With Ejector



Model 800-32
Intermediate Platen



Model 300
Transfer
Molding Press



Model 150
Transfer
Molding Press

THE NAME TO REMEMBER FOR PRECISION

Manufacturers of the World's Finest Rubber Curing Equipment

THE McNEIL MACHINE & ENGINEERING CO.

96 E. Crosier St. at Sweitzer Ave. **Akron 11, Ohio**

MANUFACTURING AGENTS: Francis Shaw & Company, Ltd., Manchester, England; Vickers-Ruwolt Proprietary, Ltd., Victoria, Australia; Luigi Pomini, Soc. in Acc. di Luigi e Carlo POMINI fu Egidio e C, Castellanza, Province of Verese, Italy; Etablissements Repiquet, Bobigny (Seine), France; Harburger Eisen Und Bronze-Werke A. G., Hamburg-Harburg, Germany.

WRITE, WIRE or TELEPHONE TODAY for complete information.

ADL Research Institute

A contract research organization, the Arthur D. Little Research Institute, has been established at Inveresk, near Edinburgh, Scotland, under the sponsorship of Arthur D. Little, Inc., Cambridge, Mass., and several prominent British educators and researchers.

The Institute, which will be staffed by British and European scientists, will undertake fundamental scientific investigations for clients. Specific or immediate commercial objectives are not to be attempted for the time being.

The costs of establishment and initial support will be borne by American funds, according to the American industrial research company, but future research projects will be open to British and Continental sponsorship on comparable terms. Projects have already been begun for some American industrial sponsors.

"Mylar"-Bonded Materials

A new process for bonding Du Pont's "Mylar" polyester film in embossed surfaces to a variety of rigid and flexible materials, including steel and aluminum, has been developed by The Seiberling Rubber Co., Akron, O.

In the process a thermosetting adhesive of unrevealed composition is applied to the material to be covered with "Mylar." The film is placed over the adhesive, and heat and pressure are applied on a giant flat-bed press designed by the company for curing thermosetting plastics. The cured bond will not soften with reheating.

According to the company, fabricators who work with materials bonded to "Mylar" can reshape them without damaging the scratch-proof, corrosion-resistant film. Stamping, drawing, spot-welding, drilling, and sawing may be done with the materials.

Among the materials Seiberling is bonding to "Mylar" are metals of all types, wallboard, pressed wood, flexible and rigid plastics, and paper. These can be used for surfacing of walls, tables, counters, radio cabinets, air conditioners, refrigerators and other household appliances, and trim for automotive parts and fixtures.

Ionics Studies for Diamond

Diamond Alkali Co., Cleveland, O., has entered into a research partnership with Ionics, Inc., Cambridge, Mass., a specialist in the application of ion exchange techniques to the modification concentration or removal of salts from solution.

Ionics will undertake the sponsorship of Diamond varied chemical research programs, including applications of ion exchange membranes developed by Ionics, according to E. R. Gilliland, Ionics president. The agreement will not affect the Cambridge firm's independent research activities.



William E. Kavenagh

Goodyear's Kavenagh, 75, Retires after 44 Years

William E. Kavenagh, director of development and research for the shoe products division of The Goodyear Tire & Rubber Co., Akron, O., retired on February 1. He has been associated with the company for 44 years, although not continuously. He is 75 years old.

One of the pioneer members of the Goodyear organization, Mr. Kavenagh first became identified with the company in Akron as a foreman in the compounding department in 1900, the company's first compounder. He resigned in 1904 to enter Harvard University, from which he was graduated with a degree in chemical engineering in 1908.

That same year he returned to Goodyear and was placed in charge of compounding in the company's first laboratory. He left again in 1916 and served with various rubber companies and as head of his own manufacturing establishment until 1925 when he resumed his association with Goodyear.

Mr. Kavenagh became head of the tire and tube compounding department in 1926, head of the sole and heel development department in 1931, and held a similar position at the company's Windsor, Vt., plant in 1936. For his part in the development of Neolite, he was given the Paul W. and Florence B. Litchfield Award. He was also on several government committees during World War II.

Third Du Pont TiO_2 Plant

E. I. du Pont de Nemours & Co., Inc., will build its third titanium dioxide plant on a 1,500-acre site near New Johnsonville, Tenn., just north of the Tennessee Valley Authority's recently expanded Johnsonville steam plant.

With an initial capacity of 125 tons of the white pigment a day, the new plant will employ 400 persons when it begins operations early in 1959. What is termed an important new process will be used for making the pigment.

Reclaimers' Group Elects

C. H. Peterson, U. S. Rubber Reclaiming Co., has been reelected president of the Rubber Reclaimers Association, Inc., New York, N. Y. Also reelected were Henry L. Dixon, B. F. Goodrich Co., as vice president; and C. T. Jansen, Rubber Age, as secretary-treasurer.

G. K. Trimble, Midwest Rubber Reclaiming Co., will serve as chairman of the Association's executive committee. T. H. Fitzgerald, Naugatuck Chemical Division of United States Rubber Co., was appointed chairman of a new educational committee, formed to implement various rubber technology courses now being given by rubber groups and colleges.

Mr. Fitzgerald's committee will also assist rubber group chairmen in obtaining speakers for technical meetings.

Leakproof Plastic Fitting

United States Rubber Co., New York, N. Y., claims the solution to the problem of leaks at joints in cemented or solvent-welded plastic pipe installations.

The answer is a paper-thin layer of plastic on a section of the inside wall of the company's new Uscoweld fittings. These are said to be made of a styrene-acrylonitrile blend which is tough and lightweight and has good corrosion resistance.

The plastic layer, a few thousandths of an inch thick, makes the inner half of the fitting slightly smaller than the outside diameter of the pipe it is used to join. A light coat of solvent-base cement on the inside of the fitting and on the pipe end softens the plastic layer so that the pipe can be pushed into place.

High-contact pressure between pipe and fitting causes a positive weld, according to the company. The weld is strong enough within seconds for ordinary handling and hardens in two hours so that it is as strong as the pipe itself.

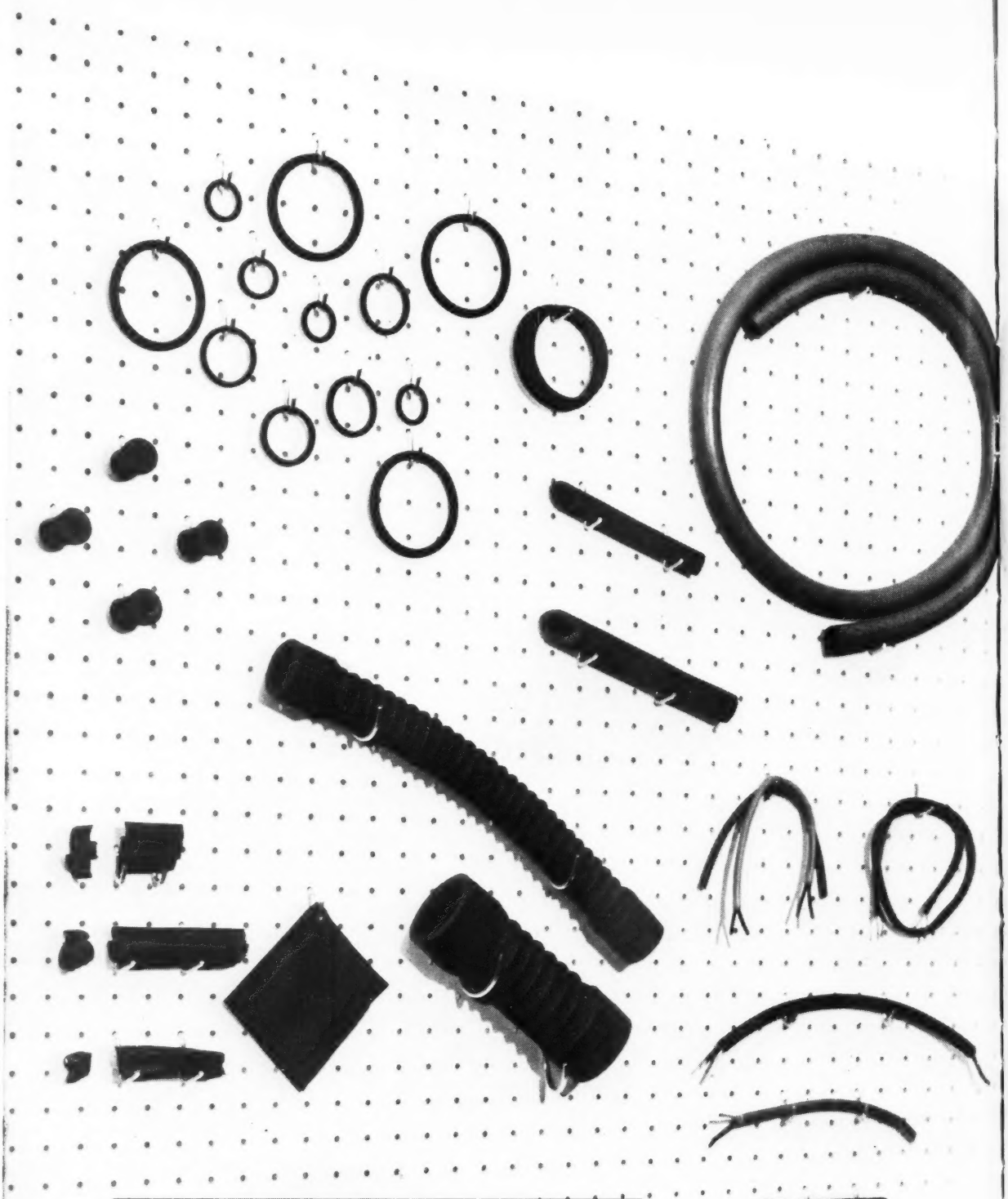
U. S. Rubber also sells Uscolite pipe and screw-type fittings made of the same styrene-acrylonitrile blend. A range of Uscoweld fittings for standard-size pipe from one-half to two inches in diameter is available.

Dayton V-Belt Seminars

The Dayton Rubber Co., Dayton, O., is conducting a series of in-plant seminars for major original-equipment manufacturers to acquaint personnel with the problems of development, manufacture, and inspection of V-belts.

The seminars were made necessary, the company says, by the fact that seven out of 10 V-belts used by major original-equipment manufacturers today are of special design for specific jobs; while only 10 years ago standard catalog sizes were used almost exclusively.

The first seminar was recently held at the Chrysler Air Temp Division for personnel from the purchasing, engineering, receiving, inspection, and quality control departments.



Because New Sundex-85 gives more Neoprene WHV compound at a lower cost, you can afford to make a greater variety of products... hoses, gaskets, grommets, sealing and packing materials, weather stripping, wire sheathing, and many other mechanical goods.

NEW SUNDEX-85 CAN GIVE YOU MORE PRODUCT PER POUND OF NEOPRENE WHV

By using high loadings of new Sundex®-85, you can lower the cost of your Neoprene WHV compound and still retain the properties that make neoprene outstanding for oil-resistant mechanical goods.

As much as 100 parts of Sundex-85 to 100 parts of neoprene hydrocarbon have been used successfully. Sundex-85 also conditions the compound for easy handling during processing.

Even with unusually high loadings of Sundex-85, neoprene products maintain their high resistance to oil, grease, ozone, heat, and sunlight. It helps assure quality in oil-resistant automotive and industrial hose, sealing and packing materials, gaskets, grommets, and other molded goods where cost is a strong factor.

Sundex-85 is compatible with neoprenes, natural rubber, butadiene-styrene type, and acrylonitrile polymers. Here are some of its typical properties:

Viscosity, SUS at 210F	90
Specific gravity at 60F	1.017
Refractive index, n_D^{20}	1.5869
Aniline point, deg F	90
Color	Dark

FOR COMPLETE INFORMATION about Sundex-85, ask your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. RW-3.

SUNOCO®

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INDUSTRIAL PRODUCTS DEPARTMENT

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Goodrich Vulcanizes Tire At AEC Gamma Facility

The successful vulcanization of an automobile tire by atomic energy has been reported by The B. F. Goodrich Co., Akron, O. The tire is said to have considerably better resistance to aging and deterioration than conventionally vulcanized tires, while the tread shows above normal resistance to abrasion and wear.

Goodrich spokesmen believe the tire is the first large commercial item ever processed by nuclear radiation and the first basic change in the curing of rubber products since the discovery of vulcanization in 1839. Nuclear vulcanization results in the direct linkage of the carbon atom chains of the rubber molecules. Ordinarily, the carbon atoms are linked through sulfur.

The vulcanization of the tire was done by Goodrich researchers at the Atomic Energy Commission's National Reactor Testing Station in Idaho. The tire, in a steel mold, was vulcanized by rotating it slowly over gamma ray-emitting fuel elements removed from a nuclear reactor. A 17-foot-deep water-filled canal was used as a protective shield.

In addition to being of higher quality than conventionally vulcanized tires, the gamma ray-vulcanized tire was processed much more rapidly. According to Goodrich, in commercial production in the future, vulcanization could be done in a cell with radiation being supplied by machines, or by radioactive by-products from a nuclear reactor. The first tire, and other radiation vulcanized tires, will undergo further tests of all types, under all conditions, to evaluate the results of this type of vulcanization.

Esso Research to Produce Butadiene by Dow Process

Esso Research & Engineering Co., New York, N. Y., has signed a license agreement to use Dow Chemical Co.'s Type B catalyst and process for making butadiene. The Dow process and catalyst have been in the commercial-development stage for several years at the Sarnia, Ont., Canada, synthetic rubber plant of Polymer Corp.

According to the Midland, Mich., company, Dow Type B catalyst is a calcium nickel phosphate material. Its use in butadiene production represents approximately a 20% increase in production efficiency over other catalysts now in use.

Dow also estimates that considerable savings in capital and plant equipment will result from its use. With modification of equipment, the catalyst can be used in butadiene manufacturing plants now in operation. Dow is presently building a plant in Ludington, Mich., to produce the catalyst.

In addition, a "semi-plant" has been built by Dow at Freeport, Tex., to continue research and development on this process, which is described as a conversion of butylene petroleum fractions to butadiene by dehydrogenation. The new unit recently began operations.

Esso Research, the central technical organization of The Standard Oil Co. (New Jersey), will make the Dow license available to its international affiliates. Esso Petroleum, Ltd., a British affiliate, plans to use the process at its new butadiene manufacturing facilities in Fawley, England, which are expected to be in operation in 1958.

News About People

S. D. Gehman, research division, The Goodyear Tire & Rubber Co., has been named an associate editor of *Rubber Chemistry and Technology*, a publication of the Division of Rubber Chemistry of the American Chemical Society. C. C. Davis, formerly with Boston Woven Hose & Rubber Co., is editor of the publication, and David Craig, B. F. Goodrich Research Center, is an associate editor.

Julius A. Lucas has been named manager of field sales, engineered products department, The Goodyear Tire & Rubber Co., Akron, O. The department has also advanced **Robert C. Gannett** to manager of automotive trim materials. **John E. Rennard** to department operating manager, **Anthony W. Webner, II,** to manager of Airfoam sales, and **H. Douglas Hurlburt** to manager of automotive floor mat sales.

Herbert Schoenfield has been appointed to the newly created position of manager of polyester sales in the chemical sales division of Witco Chemical Co., New York, N. Y. He was formerly technical sales service manager for the company's Emulsol Chemical Corp.

V. C. McQuiddy, Jr., has been appointed sales manager of textile products in the textile division of United States Rubber Co., New York, N. Y. **John H. Shaw** succeeds him as yarn sales manager. Named manager of Trilok was **Judson J. Milam, Jr.**

William T. Hepburn has been appointed manager of passenger-tire sales for The Firestone Tire & Rubber Co., Akron, O., succeeding **H. H. Vischer,** named manager of the Omaha, Neb., district.

S. Stanley Rogers, chief chemist of Pequanoc Rubber Co., Butler, N. J., has been appointed superintendent of the company's Tallapoosa, Ga., plant now under construction.

K. Jerry Morray has been appointed manager of the Cleveland sales district of the silicone products department of General Electric Co., Waterford, N. Y.

Matthew A. Noonan has been advanced to New York district manager of the sales department of Becco Chemical Division, Food Machinery & Chemical Corp., Buffalo, N. Y., and will continue to head the Philadelphia district. **Edward M. Roth** has been named assistant New York manager; while **George J. Motz** has been added to the sales staff there. **Paul U. Bretschger** has been promoted to manager of the western New York territory, which has been enlarged to include upstate New York and western Pennsylvania. **Eugene M. McMahon** has been assigned to the Philadelphia area; **Richard T. Mould,** to the Midwest area in Chicago; and **Bruce J. Bishop,** to the southern office in Charlotte, N. C.

Herschel G. Harris has been elected president of New York Rubber Corp., Beacon, N. Y., succeeding **Mark H. Stratton** who is retiring. **C. Bradley Allen** has been elected executive vice president and a director of the company.

F. T. Magennis, president, Goodyear International Corp., has been elected a director of The Goodyear Tire & Rubber Co., Akron, O., succeeding **A. G. Cameron,** who has retired.

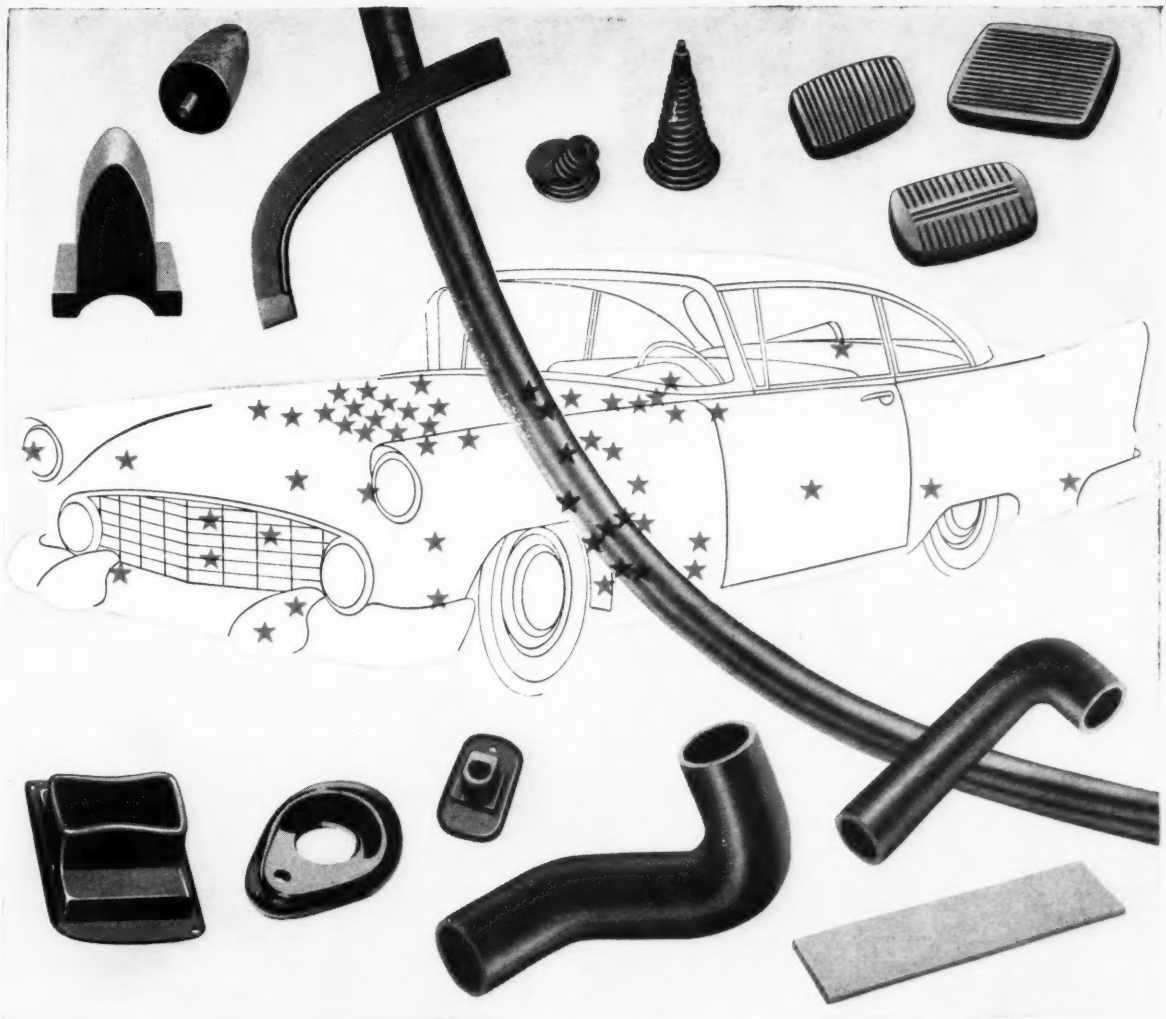
Joseph F. Shuri has joined The Sun Rubber Co., Barberton, O., as factory superintendent of rubber production. He was formerly associated with Ohio Rubber Co. **Wendell H. Stepp** has been promoted to factory superintendent for vinyl products and athletic goods and has been succeeded as general foreman of vinyl castings by **Elmer E. Davies.**

Bruce Williams has been appointed technical superintendent of Feather Industries, Ltd., Toronto, Ont., Canada.

William Hogg has been named sales manager of rubber chemicals and plastics for Naugatuck Chemical Division of Dominion Rubber Co., Ltd., Elmira, Ont., Canada, and **Art Laugheed** has been appointed sales manager of agricutural chemicals.

Charles W. Wheeler has been appointed manager of solvent sales for the chlorinated products division of Diamond Alkali Co., Cleveland, O.

V. K. Hitch has been advanced from vice president to executive vice president of Akron Chemical Co., Akron, O. **Richard L. Silver** and **R. Bruce Silver** have been named vice presidents.



★ some of the more than 100 places where ENJAY BUTYL works, silently and dependably, helping to improve the performance of today's new cars.

ENJAY BUTYL—fabulous all-weather rubber
BOOSTS PERFORMANCE IN '57 CARS

Molded into more than 100 parts, this super-durable, all-weather rubber helps provide a steadier, softer, more silent ride under even the most strenuous conditions of stress, weather change, and abrasive action. The dependability of all these parts contributes to the outstanding performance of the modern car.

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Enjay Butyl is the greatest rubber value in the world . . . the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

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Pioneer in Petrochemicals

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H. E. Coleman

H. E. Coleman has joined the polychemicals division of West Virginia Pulp & Paper Co., New York, N. Y., as sales manager.

Austin Herbst is now with Southland Paper Converting Co., Los Angeles, Calif. He previously was associated with Irvington Varnish Division, Minnesota Mining & Mfg. Co.

George A. Darsie has been appointed eastern district sales manager for the silicone products department of General Electric Co., Waterford, N. Y. He will headquarter in Newark, N. J.

Carl Dudugjian has been named technical manager of tire construction at the Los Angeles, Calif., plant of B. F. Goodrich Tire Co.

Paul N. Leech has been appointed sales representative in the Mid-Atlantic sales territory of Emery Industries, Inc., Cincinnati, O.



Paul N. Leech

Walter E. Dennis, an executive vice president of The Chase Manhattan Bank, New York, N. Y., has become a member of the board of directors of United Engineering & Foundry Co., Pittsburgh, Pa.

Reginald L. Johnson has been elected vice president of Johns-Manville Sales Corp., New York, N. Y., and has succeeded **H. M. Shackelford** as sales promotion manager. Mr. Shackelford has retired after nearly 30 years with Johns-Manville.

Charles R. Yerrick has been appointed eastern area industrial sales manager for the adhesives and coatings division of Minnesota Mining & Mfg. Co., St. Paul, Minn.

Edward Wray, chief chemist at Anaconda Wire & Cable Co., has joined Sequoia Processing Co., Redwood City, Calif.



Bryan Studio

Wayne F. Nelson

Wayne F. Nelson has been made director of research and development for A. Schulman, Inc., and will be headquartered at the firm's Akron, O., plant. He was formerly plant manager and research director of American Container Corp., a division of Gould National Batteries.

Robert C. Sutter has been promoted to operations manager of the chlorinated products division of Diamond Alkali Co., Cleveland, O., and has been succeeded as assistant director of engineering for the company by **William J. Lightfoot,** formerly chief staff engineer in the central engineering department.

Sumner L. Trilling has been advanced to general sales manager of the Bolta Products Division of The General Tire & Rubber Co., Lawrence, Mass. succeeding **Daniel E. Hogan, Jr.,** who has resigned to manage his own plastics extruding firm. **F. H. Dodkin** has been named assistant to the division's general manager.



R. W. Laundrie

R. W. Laundrie and **L. E. Gressingh** have been advanced to technical superintendent and chief process engineer, respectively, at the Mogadore, O., chemical divison plant of The General Tire & Rubber Co., Akron, O.

George H. Callum has been appointed general sales manager of manufacturers' products in the footwear and general products division of United States Rubber Co., New York, N. Y. He is succeeded as sales manager of Naugahyde vinyl coated fabrics by **William J. Mulvey.**

Fred Owen, formerly with W. J. Voit Rubber Co., is now associated with Gross Mfg. Co., Inc., Monrovia, Calif.

T. W. Brasfield has been named Los Angeles, Calif., district sales manager for Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn., succeeding **G. L. Dennis** who has transferred to Naugatuck. **Otto P. Steinen** has been appointed to succeed Dr. Brasfield as sales manager for agricultural chemicals.

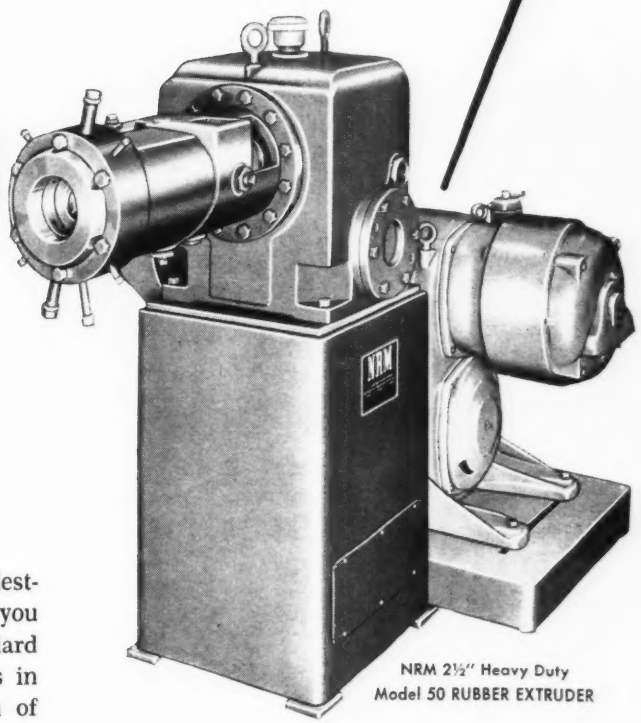


T. W. Brasfield

Biggest PRODUCER for its size on the market...

NRM 2½"

RUBBER EXTRUDER



NRM 2½" Heavy Duty
Model 50 RUBBER EXTRUDER

Use it for

- BEAD WIRE INSULATION
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Size for size, here's the busiest, hardest-working profit maker in rubber extruders you can obtain. Long the tire industry's standard for bead wire insulation, it also "doubles in extrusions" to handle regular production of profiles and pre-mold stock, or to make compound development and pilot operations fast, accurate and economical.

The 2½" Extruder is the quality equal of any large machine in the NRM line, and has many such "big extruder" features as corrosion-resistant Xaloy cylinders for long wear life; under-cut feed boxes for continuous feeding of variously sized stock; and heavy-duty, self-lubricating gear reduction units for durability and long, trouble-free operation.

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on this "biggest little extruder" in the industry. See *why* it, or any other Extruder in the NRM full line, offers *most for the money* in design, construction and profitable operation.

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WEST: S. M. Kipp, Box 441, Pasadena 18, Cal.
MID-WEST: National Rubber Machinery Co., 5875 N. Lincoln Ave., Chicago 5, Ill.
EXPORT: Gillespie & Company, 96 Wall St., New York 6, N. Y.



Photo by Michael Burns

J. G. Edmiston



William J. Esselstyn

L. J. Polite, Jr., has been advanced to product sales manager of the chlorinated products division of Diamond Alkali Co., Cleveland, O. **William J. Esselstyn** has been promoted to manage organic intermediates and new product sales for the division.

H. K. J. de Decker, formerly research director of Rubber Stichting and more recently on the staff of the research and development department of United States Rubber Co., has been appointed head of the polymer research section, research and development department, Texas-U. S. Chemical Co., New York, N. Y. **Walter Nudenberg,** formerly a member of the chemistry department of the University of Chicago, has been named head of the company's exploratory chemical research section.

Richards Burhoe has been named St. Paul branch sales manager for the industrial trades tape division of Minnesota Mining & Mfg. Co., St. Paul, Minn.

J. G. Edmiston has been appointed product sales manager for rubber chemicals for Monsanto Canada, Ltd., Montreal, P.Q., Canada.

W. D. Marshall, Philadelphia district sales manager for the industrial chemicals division of Olin Mathieson Chemical Corp., New York, N. Y., has been assigned to new sales duties of an undisclosed nature and is succeeded by **J. G. Johns. Victor C. Fusco** and **Don Threlkeld** have been named sales representatives to the Pittsburgh and Chicago areas, respectively.

Albert P. Shutts has been promoted to assistant sales manager of Becco Chemical Division, Food Machinery & Chemical Corp., Buffalo, N. Y.

William H. Jefferson has been appointed general manager of General Latex & Chemical Corp. (of Ohio), Ashland, O.



Mervyn T. Walsh

Mervyn T. Walsh has been appointed manager of muriatic acid sales for the chlorinated products division of Diamond Alkali Co., Cleveland, O. He will continue to manage sales of Chlorowax.

Alan G. Richards has been appointed director of applications for Bjorksten Research Laboratories for Industry, Madison, Wis.

Sheldon H. Ingram has been named Pittsburgh branch manager of Fairbanks Co., New York, N. Y.

John W. Weisel has joined B. F. Goodrich Chemical Co. as a junior technical man at the company's plant No. 3 in Akron, O.

Stanley J. Dumovich has been assigned to the Houston, Tex., chemical sales office of Atlas Powder Co., Wilmington, Del.

T. J. Hall has been named manager of fine chemicals for the fine chemicals department of Carbide & Carbon Chemicals Co., New York, N. Y. **D. S. Alcorn** has become assistant manager of fine chemicals.

L. W. Reeves, since 1954 manager of chemical sales for the chemical division of The General Tire & Rubber Co., Akron, O., has been named director of rubber and rubber chemical sales. **George Hackim** has been appointed head of the newly formed sales development department, while continuing as manager of vinyl resin sales. **Paul J. Earley** has become director of a new technical service department. **James Hostettler** has been made senior salesman for synthetic rubber, and **Norman Phillips** has been appointed sales development engineer to assist Mr. Hackim. Named synthetic rubber field representatives are **Victor E. Buehrle,** for Akron West; **Edmond B. Deckel,** for Akron East; **Vincent T. Cox** and **Richard B. Daley,** for Boston; **Edward McBride,** for New York; and **Phillip Mackler,** for Chicago.

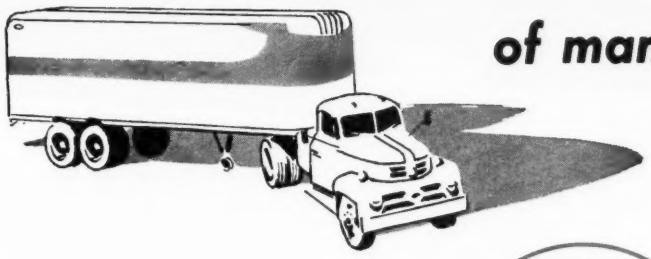


L. W. Reeves



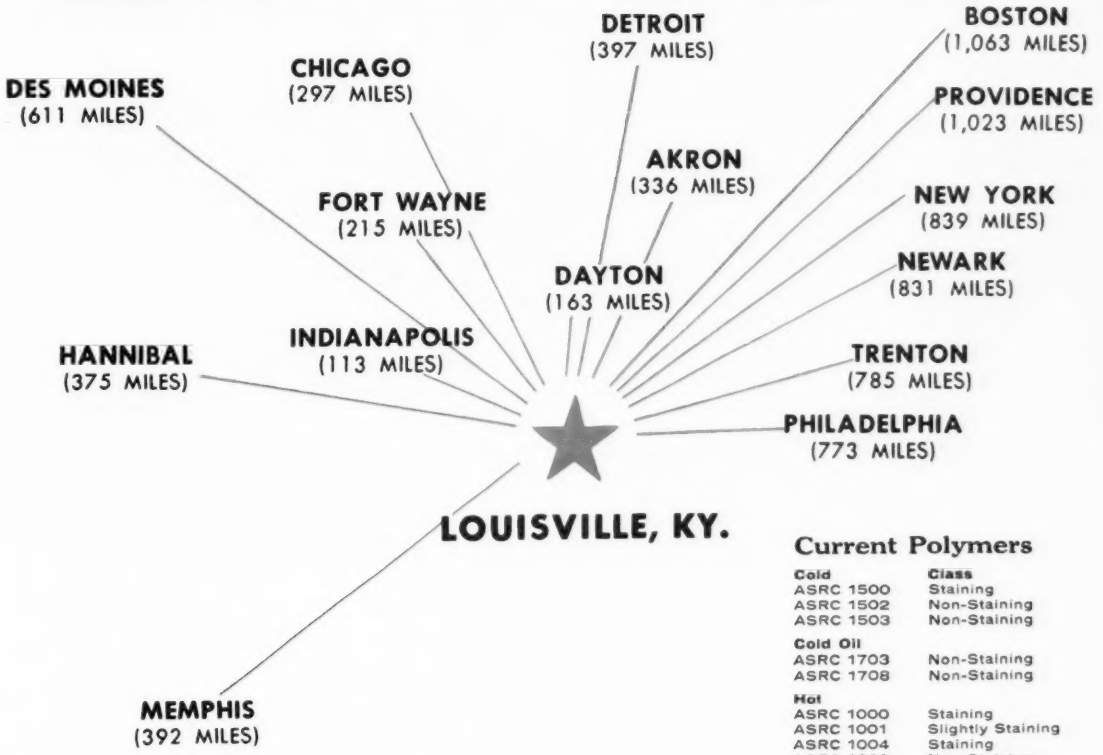
George Hackim

Within overnight trucking distance of many key points . . .



ASRC

located at the "Hub" of the rubber market



Current Polymers

Cold	**Class**
ASRC 1500	Staining
ASRC 1502	Non-Staining
ASRC 1503	Non-Staining
Cold Oil	
ASRC 1703	Non-Staining
ASRC 1708	Non-Staining
Hot	
ASRC 1000	Staining
ASRC 1001	Slightly Staining
ASRC 1004	Staining
ASRC 1006	Non-Staining
ASRC 1018	Non-Staining
ASRC 1019	Non-Staining

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Roland H. Guinzburg

Roland H. Guinzburg, since 1954 executive vice president of I. B. Kleinert Rubber Co., New York, N. Y., has been elected president of the firm, succeeding the late Ralph Kleinert Guinzburg. The new president joined the company in 1911 as a chemist.

O. A. Schilling and **H. R. Comstock** have been promoted to sales manager and assistant sales manager, respectively, of the industrial products division of The Goodyear Tire & Rubber Co., Akron, O. **R. E. Chapman** has been advanced to manager of the central sales region for the division; while **R. E. Mercer** has been promoted to manager of hose sales.

W. D. Waugh has been appointed president of Firestone International Co., Akron, O., succeeding **Samuel Broers,** who retired in January after 40 years of service with the company. Mr. Waugh, who joined Firestone in 1927, has been managing director of the company's Port Elizabeth, South Africa, subsidiary since 1942. **W. E. Kemerer** has been advanced to vice president of Firestone International.



W. D. Waugh

James A. Wold has been named general manager for the consumer products department of the chemical division of Borden Co., New York, N. Y.

John S. Clapp is now chairman of the board of New Jersey Rubber Co., Taunton, Mass.; while **Allen N. Clapp** has been named president.

Philip J. Lowry and **L. Dean Tyler** have been named managers of the Akron and eastern sales districts, respectively, for Mobay Chemical Co., St. Louis, Mo.

S. A. Steere, since 1947 vice president of Goodyear Fabric Mills, Akron, O., and associated with the company since 1919, retired January 31. **William K. Wilder** has been named manager of Goodyear Fabric Mills at Cartersville, Rockmart, and Cedartown, Ga., and at Decatur, Ala.



Floyd W. Green

Floyd W. Green has been promoted to director of technical service of Imperial Paper & Color Corp., Glens Falls, N. Y.

Alex L. Semegen has been appointed advertising manager of International B. F. Goodrich Co., Akron, O.

Earl V. DeGraw has been advanced to assistant manager of the truck tire sales department of The Goodyear Tire & Rubber Co., Akron, O.

Charles W. Mitchell has been appointed vice president of Stauffer Chemical Co., New York, N. Y., and general manager of its Nyotex Chemicals Division. He will headquarter in Houston, Tex.

Charles P. McHugh, since 1954 assistant director of research and product design for Manhattan Rubber Division of Raybestos-Manhattan, Inc. Passaic, N. J., has been advanced to director. He succeeds **William L. White,** who has assumed the role of technical consultant.



William Hagel

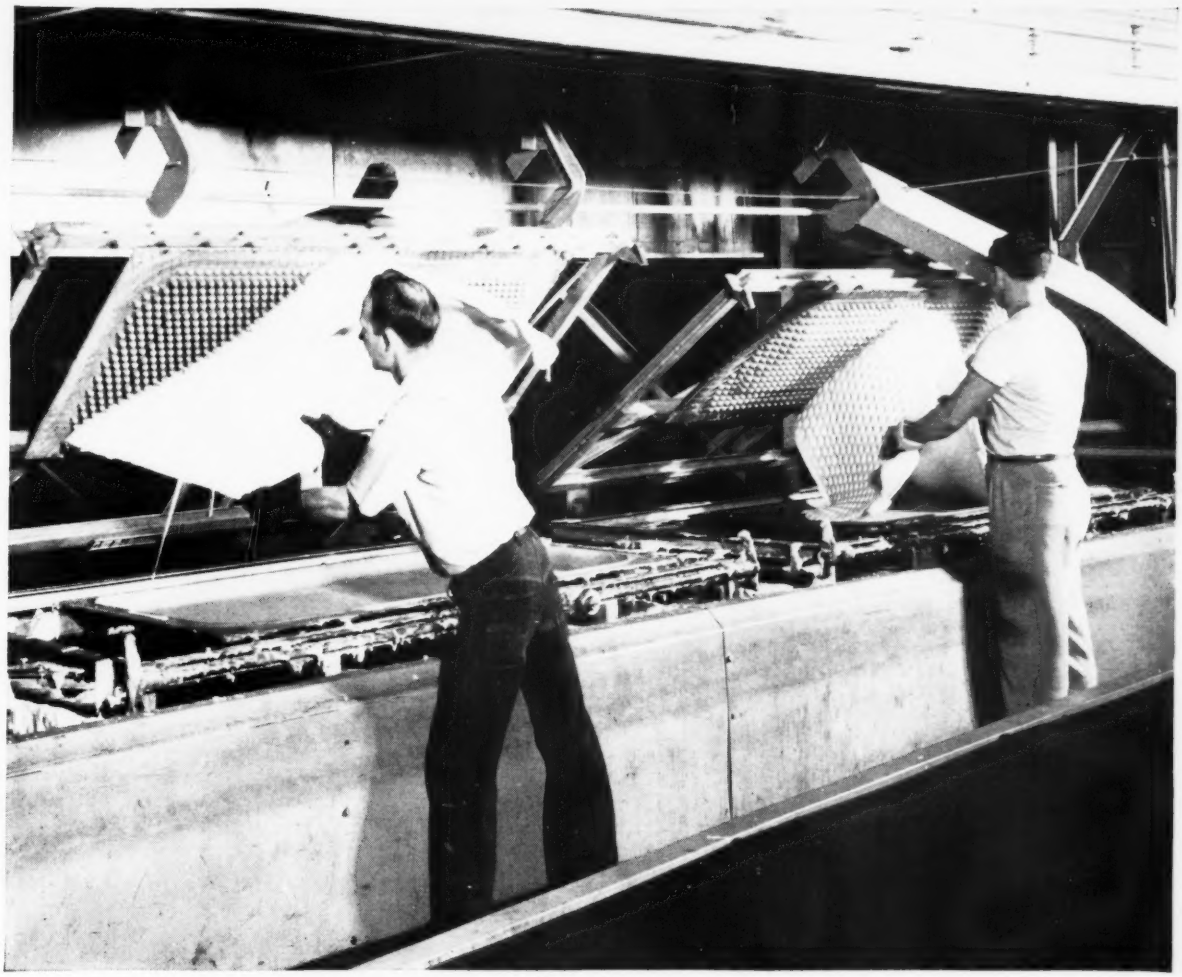
William Hagel has been advanced to vice president in charge of operations for United Engineering & Foundry Co., Pittsburgh, Pa., while continuing to supervise the firm's estimating and sales contract departments.

E. Lacy, R. W. Krajicek, B. B. Herron, and **Horace V. Wells** have been reassigned as technical field service representatives for Oakite Products, Inc., New York, N. Y., to Houston, Tex.; Lake Charles, La.; Beaumont, Tex.; and Corpus Christi, Tex., respectively. Newly assigned as technical representatives are **Robert H. Bourbonnais,** to Lansing, Mich.; **J. C. Ruttle,** to Detroit, Mich.; **Harry H. Thomas,** to Cedar Rapids, Iowa; **William G. Caffee,** to Birmingham, Ala.; **Andrew C. Johnston,** to Washington, D. C.; and **Theo L. Matula,** to San Antonio, Tex.

Wallace H. Woodrow has joined The Dayton Rubber Co., Dayton, O., as vice president in charge of engineering. His past associations include Hale & Kullgren, Inc., and Monsanto Chemical Co., plastics division.



Wallace H. Woodrow



Both first and foam-most!

First and foremost choice of a number of manufacturers of foamed rubber products is one of two Goodyear latices–PLIOLITE LATEX 2104 or PLIOLITE LATEX 2105.

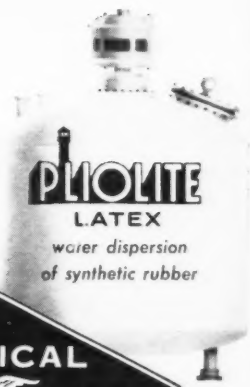
PLIOLITE LATEX 2104 is a "cold" polybutadiene latex which exhibits virtually no odor. This feature plus its high solids content and excellent mechanical stability make PLIOLITE LATEX 2104 extremely well-suited to the production of pillows, mattresses and other types of cushioning.

PLIOLITE LATEX 2105 is a "cold," high solids, butadiene/styrene latex. It, too, exhibits excellent mechanical stability with light color, high physical properties and low temperature flexibility–for advantageous use in foamed goods where very slight odor is permissible.

In addition to these latices, there are a number of other rubber and resin latices in the PLIOLITE family. Each can be used alone or in combination with the others to obtain specific properties in foam or any of the many applications for latex.

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Goodyear, Chemical Division, Akron 16, Ohio



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High Polymer Resins, Rubbers, Latices and Related Chemicals for the Process Industries



Pach Bros.

George R. Vila

George R. Vila has been elected a vice president of United States Rubber Co., New York, N. Y., and appointed general manager of its Naugatuck Chemical Division. He succeeds **John E. Caskey,** who is retiring after 42 years of service with the company. Mr. Vila, advanced from assistant general manager of Naugatuck, joined U. S. Rubber in 1936 as a salesman in the rubber chemicals department. He became assistant manager of research and development for Naugatuck in 1945, general sales manager in 1952, and assistant general manager the following year.

John A. Adams has been appointed manager of materials for the silicone products department, General Electric Co., Waterford, N. Y. **Richard D. Rice** and **John H. Clement** have been named general foremen at the plant.

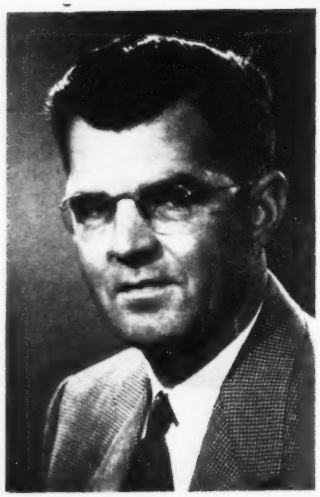
Robert D. MacDonald has been promoted to manager of products control and development, retail trades tape division, Minnesota Mining & Mfg. Co., St. Paul, Minn.

Harold K. Latourette has been advanced to manager of organic research and development at Becco Chemical Division, Food Machinery & Chemical Corp., Buffalo, N. Y.

Bob Kavish, formerly with American Mineral Spirits Co., has joined General Electric Co., Los Angeles, Calif.

Eugene F. Hoffmann has become manager of the Cincinnati sales office of U. S. Industrial Chemicals Co., New York, N. Y., succeeding **Elmer Bulthaup,** who died in January.

E. J. Thomas, president, The Goodyear Tire & Rubber Co., Akron, O., has been elected a member of the board of trustees of the American Heritage Foundation, a non-partisan organization created to encourage greater participation in elections.



H. Herman Abernathy

H. Herman Abernathy has been named to head a new sales development group in the elastomer chemicals department of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Others appointed to the group are **Don R. Kuespert, W. Vance Freed, Harold B. Schwartz, M. A. Youker,** and **Lee R. Eckman.**

Arthur M. Worden has been promoted to Boston, Mass., branch sales manager, industrial trades tape division, Minnesota Mining & Mfg. Co., St. Paul, Minn.

William E. Campaigne has joined Godfrey L. Cabot, Inc., Boston, Mass., as technical representative in Akron.

Donald A. Handy has joined The Seiberling Rubber Co., Akron, O., as manager of a newly created methods department.

J. V. Carlin, Jr., manager of industrial product sales for Acme Rubber Mfg. Co., Trenton, N. J., has been advanced to general sales manager, succeeding his father, **J. V. Carlin, Sr.,** semi-retired.

James A. Merrill, manager of the technical division of Goodyear Atomic Corp., Portsmouth, O., is returning to the parent company, The Goodyear Tire & Rubber Co., Akron, O., as associate director of research and development.

Westman Rubber Works, Compton, Calif., has been formed to manufacture molded rubber specialties for the oilfield and aircraft industries. Walt Westman is president.

News Briefs

B. F. Goodrich Industrial Products Co., Akron, O., has had delivered to a Venezuelan mining company the largest one-piece conveyor belt it has ever made. Weighing 22½ tons, the rayon-and-nylon-filled belt was more than 1,000 feet long and 60 inches wide and can carry 100 tons of iron ore a minute.

The Firestone Tire & Rubber Co., Akron, O., is offering free a laminated Bristol-board farm-tractor air-measure tire gage. The device measures tread depth and distance between the rim and the ground, giving an accurate measurement of tire pressure.

Bond Adhesives Co. has transferred its facilities from Brooklyn, N. Y., to Jersey City, N. J. The firm distributes Goodyear's Pliobond adhesives.

The Goodyear Tire & Rubber Co., Akron, O., has formed The Goodyear International Corp. to replace The Goodyear Tire & Rubber Export Co. which has heretofore conducted its foreign business. F. T. Magennis was named president, and E. E. Long, vice president.

Monsanto Chemical Co., plastics division, Springfield, Mass., is providing newly developed Ultron R-402 rigid vinyl sheeting to the National Broadcasting Co. for vacuum-forming of scenery used in color telecasting. Available in 10- to 20-gage thickness, Ultron R-402 is said to have high opacity, good impact strength, and a smooth surface for painting or printing.

Dunlop Canada, Ltd., Toronto, Ont., Canada, has had a slowdown of production at its Queen St. East plant due to picketing by the United Rubber Workers' Union over handling of grievances, wages paid in certain installation projects, and safety conditions.

Baldwin-Lima-Hamilton Corp. has completed the transfer of its manufacturing and sales operations of its hydraulic and compacting press department from the Eddystone Division to the Hamilton Division, Hamilton, O.

Standard Oiled Clothing Co., New York, N. Y., has introduced waterproof neoprene heavy-duty suits for construction and industrial workers.

"BLACKS?"

"TOP QUALITY" says the Lab

"CONSISTENT RESULTS" says Production

"SERVICE AND ECONOMY" says Purchasing



Rubber compounders benefit from Witco-Continental's long experience in the manufacture, sale and servicing of the full line of furnace and channel blacks to the rubber industry. Any one of them can be counted on for dependable service in your products.

FURNACE BLACKS

Continex® SRF • Continex SRF-NS • Continex HMF
Continex HAF • Continex FEF • Continex ISAF • Continex CF

CHANNEL BLACKS

Continental® AA – (EPC) – Witco No. 12
Continental A – (MPC) – Witco No. 1
Continental F – (HPC) – Witco No. 6
Continental R-40 – (CC) – Conducting

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CHEMICAL PROGRESS WEEK APRIL 8-12

Borden Co., chemical division, has transferred its monomer-polymer laboratories from Leominster, Mass., to 5000 Langdon St., Philadelphia, Pa. Borden's Dajac laboratories have also been moved from Leominster to the Philadelphia site. Both are under the direction of K. C. Tsou.

Wellco-Ro-Search, Waynesville, N. C., has been visited by Sung Myung Choi, engineer of Hankook Tire Industrial Co., Ltd., Seoul, Korea, who studied footwear manufacturing methods. Hankook is the largest rubber products manufacturer in South Korea.

Beckman Instruments, Inc., Fullerton, Calif., has acquired Statham Laboratories, Inc., Los Angeles, Calif., in a stock exchange. Statham, manufacturer of precision pressure transducers, accelerometers, and other aircraft devices, has an annual sales volume of about $5,000,000.

Jefferson Chemical Co., Inc., Houston, Tex., has opened a new sales office at 802 Fidelity Bldg., Cleveland, O. The company, jointly owned by American Cyanamid Co. and The Texas Co., produces synthetic organics from hydrocarbons.

The Goodyear Tire & Rubber Co., chemical division, has moved its Boston, Mass., field office to 66 B St., Needham Heights, and its Cleveland, O., field office to the new distribution center at 18901 Five Points Rd., Brook Park, O. (P. O. Box 326, Berea, O.)

Thermatomic Carbon Co., New York, N. Y., is expected to be merged into Commercial Solvents Corp., New York, N. Y., when stockholders of both companies have their annual meetings in early April.

Middletown Rubber Corp., Middletown, Conn., is marketing a three-dimensional valley printed vinyl fabric called Tri-Tex for automotive and furniture upholstery and other uses.

Jerguson Gage & Valve Co. has moved into its new plant and general offices in Burlington, Mass. The new facilities are twice as large as the firm's former plant in Somerville, Mass.

Parker Appliance Co., Los Angeles, Calif., has absorbed Franklin C. Wolfe, Inc., Culver City, Calif., producer of plastic molded goods, which will operate as a division of Parker.

Naugatuck Chemical Division, United States Rubber Co., is tripling laboratory and office space at its agricultural chemical research station and experimental farm at Bethany, Conn.

Wheelco Instruments Division, Barber-Colman Co., has established a new branch sales office at 522 E. Jefferson St., Springfield, Ill., with LeRoy Peterson as manager.

Wellco-Ro-Search, Waynesville, N. C., has sent its chief chemist, Anton Liebscher, on a technical instruction trip to affiliated Ro-Search factories in Turkey, Iraq, Iran, India, Hong Kong, Formosa, Australia, New Zealand, and the Philippines.

Jefferson Chemical Co., Inc., Houston, Tex., is offering a new free-flowing form of high-purity piperazine, whose derivatives are expected to have application in the rubber industry as accelerators, stabilizers, surface active agents, resins, and polymers.

The General Tire & Rubber Co., Akron, O., is supplying its Syloy sign panels for the new Massachusetts East-West Turnpike. Made of plastics-reinforced fiberglas, the molded signs are said to be virtually indestructible and weatherproof. They are manufactured at the company's Marion, Ind., division.

The Goodyear Tire & Rubber Co., packaging films department, Akron, O., has announced an improved 80 FM-1 Pliofilm for packaging of fresh meats which is said to be more durable and puncture-resistant than similar materials.

The General Tire & Rubber Co., Akron, O., is conducting a nation-wide, month-long publicity campaign on behalf of the trucking industry, its third annual effort.

Dewey & Almy Chemical Co. of Canada, Ltd., Montreal, P.Q., has appointed Drew Brown, Ltd., Montreal, Canadian distributor for most of its organic chemical products.

The Goodyear Tire & Rubber Co., sales division-foam products, has moved its eastern field sales office from the company's Akron Plant C to 9-23 Alling St., Newark, N. J.

Obituaries



James C. Clinefelter

James C. Clinefelter

James C. Clinefelter, Midwest representative for John Royle & Sons, Paterson, N. J., died in Akron General Hospital on December 11 after a brief illness. Burial was in Rose Hill Cemetery, Akron, December 15.

Mr. Clinefelter began his career with Portage Rubber Co., where he was chief engineer from 1917 to 1921. He then went to Akron Standard Mold Co. as sales manager, leaving it in 1924 to become sales manager for Akron Rubber Machinery Co. He joined John Royle in 1924 as Midwest representative, with offices in Akron.

Mr. Clinefelter was assigned several patents covering rubber machinery and processing methods.

The deceased was born in Princeton, Pa., 64 years ago.

He is survived by his two sons.

Fritz Hofmann

Fritz Hofmann, known throughout the rubber world for his work on the synthesis of rubber, died in Hannover, Germany, October 30, 1956.

He was born on November 2, 1866, in Kolleda, Thuringia.

After completing his studies in pharmacy and chemistry, the deceased joined the Farbenfabriken vormals Friedrich Bayer, of Elberfeld-Leverkusen, in 1897, as chemist in the pharmaceutical department of the firm.

In 1906 he became interested in the investigation of polymerizable diolefins and by 1909 had succeeded in the experimental preparation of the first synthetic rubber types. This work enabled Germany to produce fairly substantial quantities of methyl rubbers when the blockade during World War I cut her off from natural rubber supplies.

From 1918 to 1934, Professor Hofmann directed the Kaiser-Wilhelm-Institute for Coal Research,in Breslau, and his continued research on the polymerization of diolefins laid the foundations for the

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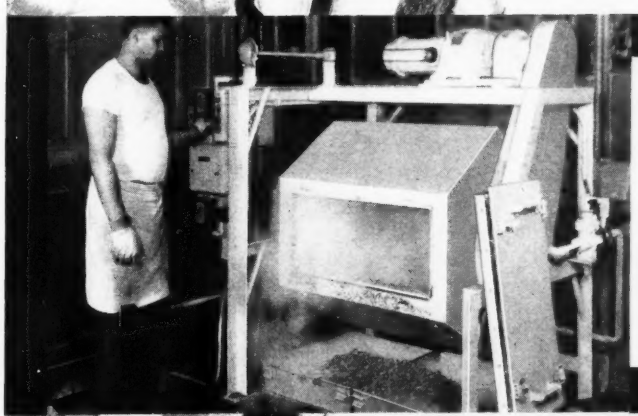


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subsequent large-scale synthesis of the Buna rubbers. He also at this time contributed to the development of accelerators and anti-oxidants for rubber.

In 1945 he left Breslau. His valuable scientific investigations were recognized at home and abroad. The Association of the Germany Rubber Industry made him an honorary member, and in 1954 the West German Government awarded him the Grand Cross of the Order of Merit.

Edwin A. Foote

Edwin A. Foote, technical committee coordinator for the mechanical rubber goods division of The Rubber Manufacturers Association, Inc., New York, N. Y., died January 11 of coronary thrombosis.

He was born in Brooklyn, N. Y., on April 14, 1898. Mr. Foote was graduated from Drake Business School, New York, in 1915. He served as secretary to the NRA Industry Commissioner in 1933 and joined the RMA the following year as assistant to A. D. Kunze. In 1944 he assumed the position he held at the time of his death.

Mr. Foote was a lifetime devotee of the theater, art, literature, and music.

Funeral services were held at Metzner Funeral Home, Brooklyn, January 14.

Cremation took place the following day.

The deceased is survived by a brother and a nephew.

Roger A. Mathes

Roger Alfred Mathes, a section leader in rubber chemicals research at The B. F. Goodrich Co. Research Center, Brecksville, O., died January 24 of coronary thrombosis.

Mr. Mathes joined U.S. Gypsum Co. upon his graduation from Cornell University in 1925 with a B. Chem. He became associated with Goodrich two years later.

Mr. Mathes was the author of 14 published articles on organic chemistry and rubber compounding and had 62 patents assigned to him.

He held membership in the American Chemical Society, the Akron Rubber Group, and the American Association for the Advancement of Science.

The deceased was born in Batavia, N. Y., on May 26, 1903.

Surviving is the widow.

Funeral services were held for him at Billows Funeral Home, Akron, O., January 28. Burial was in Rose Hill Cemetery, Akron, the same day.

•

Financial

Pennsylvania Salt Mfg. Co., Philadelphia, Pa., and consolidated subsidiaries. Year ended December 31, 1956: net earnings, $3,626,441, equal to $2.92 a common share, against $3,484,238, or $2.80 a share, in the preceding 12 months; sales, $72,416,526, against $67,775,032; provision for income taxes, $3,587,365, against $3,624,088.

Aetna-Standard Engineering Co., Pittsburgh, Pa. Second half, 1956: net income, $647,717, equal to $1.40 a share, compared with $558,573, or $1.21 a share, a year earlier.

American Brake Shoe Co., Detroit, Mich. For 1956: net profit, $8,963,000, equal to $6.64 a share, against $6,442,000, or $5.08 a share, in 1955.

American Cyanamid Co., New York, N. Y. For 1956: net income, $44,247,158, equal to $4.21 a share, against $38,713,666, or $4.07 a share, in 1955.

American Zinc, Lead & Smelting Co., Columbus, O. For 1956: net income, $3,227,864, equal to $2.74 a share, against $2,592,232, or $2.20 a share, in 1955.

General Tire & Rubber Co., Akron, O., and consolidated subsidiaries. Year ended November 30, 1956: net profit $10,860,129, equal to $6.90 each on 1,379,981 common shares, compared with $11,600,463, or $8.44 each on 1,244,423 shares, in the preceding fiscal year; net sales, $390,471,772 (a new high), against $295,731,096; income taxes, $10,963,000, against $10,034,000; current assets, $147,028,874, current liabilities, $78,084,809, against $122,800,564 and $70,401,419, respectively, on November 30, 1955.

Goodyear Tire & Rubber Co., Akron, O., and subsidiaries. Year ended December 31, 1956: net earnings, $62,456,130 (a record), equal to $6.02 each on 10,361,605 common shares, compared with $59,665,845, or $5.76 each on 10,105,312 shares, in the preceding year; net sales, $1,358,763,538, against $1,372,176,139; income taxes, $66,299,000, against $66,966,000; current assets, $564,629,591, current liabilities, $113,296,331, against $547,908,073 and $87,355,623, respectively, on December 31, 1955.

Hercules Powder Co., Wilmington, Del. For 1956: net income, $17,702,985, equal to $2.13 a common share, compared with $19,012,125, equal to $2.30 a share, in 1955; sales, $235,902,914, a new high, against $226,651,058; income taxes, $29,838,274, against $23,336,262.

Liquid Carbonic Corp., Chicago, Ill. Last quarter, 1956: consolidated net income, $759,971, equal to 65¢ each on 1,156,029 common shares, compared with $510,839, or 45¢ each on 1,044,712 shares, a year earlier; net sales, $8,258,611, against $7,380,169.

Hooker Electrochemical Co., Niagara Falls, N. Y., and subsidiaries. Year ended November 30, 1956: net income, $11,496,697, equal to $1.75 a common share, against $11,377,023, or $1.72 a share, in the preceding fiscal year; net sales, $109,979,691 (a record), against $104,274,970; federal income taxes, $11,627,393, against $11,703,054.

Johns-Manville Corp., New York, N. Y. For 1956: net income, $25,002,610 (a new high), equal to $3.79 a share,, against $23,511,183, or $3.68 a share, in 1955; sales, $310,390,381 (another record), against $284,741,498.

Johnson & Johnson, New Brunswick, N. J. For 1956: net earnings, $12,946,718, equal to $6.14 a share, against $11,311,904, or $5.38 a share, in 1955.

Monsanto Chemical Co., St. Louis, Mo., and consolidated subsidiaries. For 1956: net profit, $38,645,533, equal to $1.80 each on 21,446,461 common shares, compared with $42,169,970, or $1.98 each on 20,998,945 shares, the year before; net sales, $541,883,474, a record, against $522,349,097; income taxes, $30,764,000, against $36,898,000.

Nopco Chemical Co., Harrison, N. J. For 1956: net profit, $1,584,727, equal to $3.15 a share, against $1,535,733, or $3.05 a share, in 1955.

Parker Appliance Co., Cleveland, O. Second half, 1956: net earnings, $725,698, equal to $1.87 a share, contrasted with $65,592, or 17¢ a share, in the last half of 1955.

Plymouth Rubber Co., Inc., Canton, Mass. For 1956: net profit, $917,005, equal to $1.05 a share, contrasted with $462,905, or 51¢ a share, in 1955.

H. K. Porter Co., Inc., Pittsburgh, Pa. For 1956: net profit, $7,594,534, equal to $7.07 a share, compared with $6,433,107, or $6.15 a share, in the preceding year.

St. Joseph Lead Co., New York, N. Y. For 1956: net earnings, $10,291,357, equal to $3.79 a capital share, contrasted with $12,729,820, or $4.68 a share, in 1955.

Sun Oil Co., Philadelphia, Pa. For 1956: net earnings, $56,160,000, equal to $5.22 a share, against $48,307,360, or $4.72 a share, in 1955.

(Continued on page 956)

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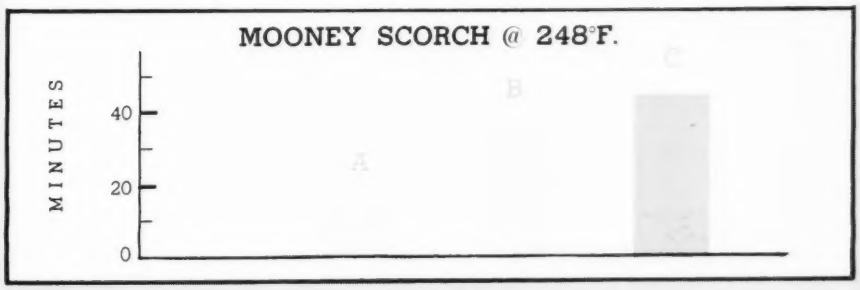
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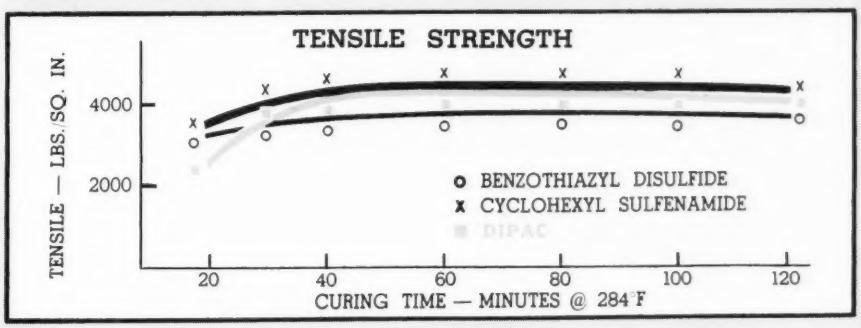
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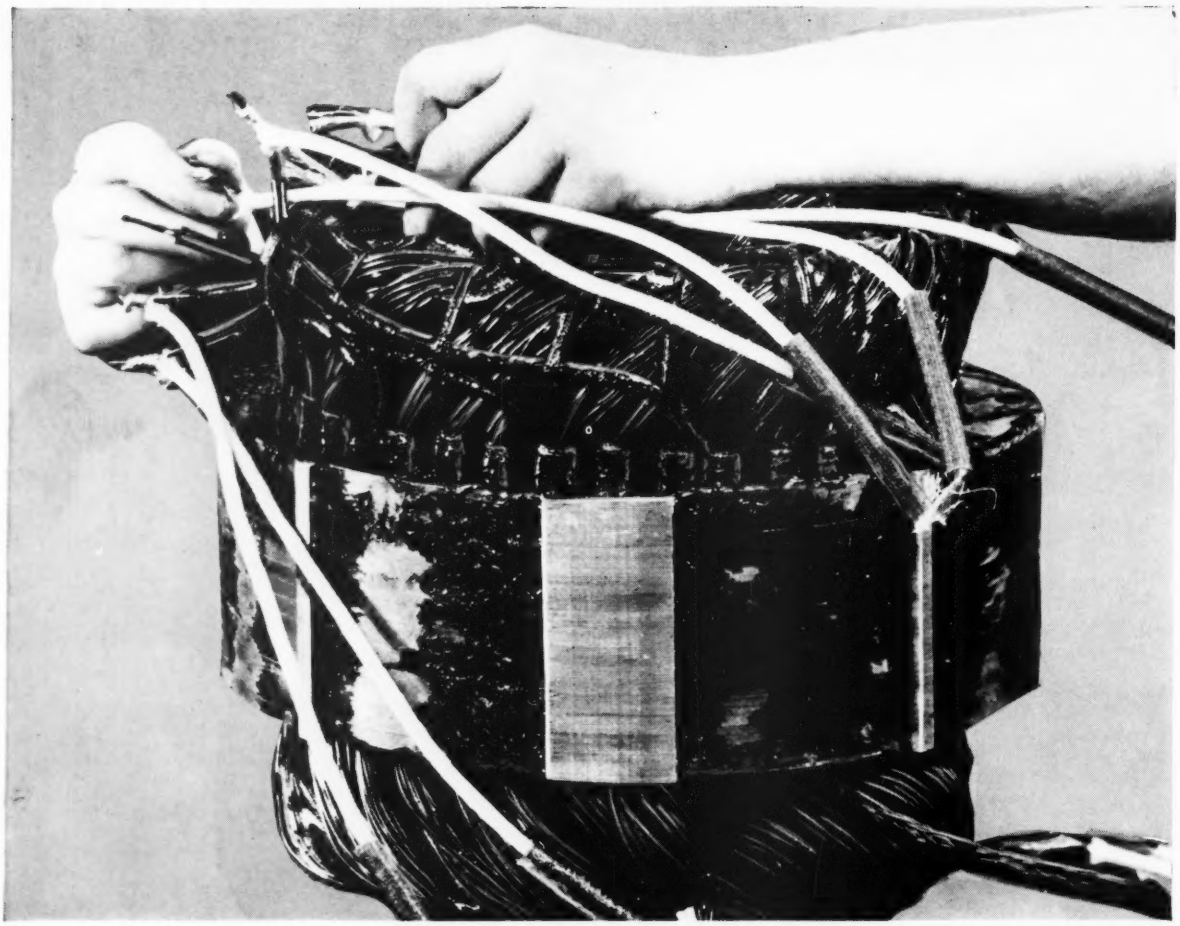
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CALENDAR of COMING EVENTS

March 15

Chicago Rubber Group. Furniture Club, Chicago, Ill.

Boston Rubber Group. Spring Meeting. Hotel Somerset, Boston, Mass.

March 17

Northeastern Section, ACS, and Its Elastomer & Plastics Group. Joint Meeting. Symposium on Adhesives.

March 18-21

Society of the Plastics Industry, Inc. 1957 National Conference and Pacific Coast Plastics Exposition. Biltmore Hotel, Los Angeles, Calif.

March 20

Washington Rubber Group. Pepco Auditorium, Washington, D. C.

March 20-22

Society of Automotive Engineers. Production Meeting & Forum. Buffalo, N. Y.

March 21-23

Division of High Polymer Physics, APS. Seventeenth Meeting. University of Pennsylvania, Philadelphia, Pa.

March 22

New York Rubber Group. Spring Meeting. Henry Hudson Hotel, New York, N. Y.

March 28

Commercial Chemical Development Association. Annual Open Meeting—"The Plastics Industry." Hotel Statler, New York, N. Y.

Southern Ohio Rubber Group.

April 2

The Los Angeles Rubber Group, Inc. Biltmore Hotel, Los Angeles, Calif.

April 4

Rhode Island Rubber Club.

April 5

Akron Rubber Group. Spring Meeting. Sheraton Mayflower Hotel, Akron, O.

April 8-9

Ninth Conference on Electrical Engineering Problems in the Rubber and Plastics Industries. Mayflower Hotel, Akron, O. AIEE Industry Committee.

April 8-10

American Society of Mechanical Engineers. Spring Meeting. Hotel Dinkler-Tutwiler, Birmingham, Ala.

April 11

Fort Wayne Rubber & Plastics Group. Van Orman Hotel, Fort Wayne, Ind.

Northern California Rubber Group.

April 12

Detroit Rubber & Plastics Group, Inc. Spring Meeting. Detroit Leland Hotel, Detroit, Mich.

Philadelphia Rubber Group. Poor Richard Club, Philadelphia, Pa.

April 14-27

United States World Trade Fair. Coliseum, New York, N. Y.

April 16-18

American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, Society for Non-Destructive Testing. Symposium on Nuclear Tests for Non-Destructive Testing Applications. Morrison Hotel, Chicago, Ill.

April 16

Elastomer & Plastics Group, Northeastern Section, ACS. Trip to Owens Corning Fiberglas Plant, Ashton, R. I.

April 17

Washington Rubber Group. Pepco Auditorium, Washington, D. C.

April 26

Chicago Rubber Group. Furniture Club, Chicago, Ill.

April 29-May 3

American Material Handling Society Conference; Materials Handling Exposition. Convention Hall, Philadelphia, Pa.

May 7

The Los Angeles Rubber Group, Inc. Biltmore Hotel, Los Angeles, Calif.

May 9

Northern California Rubber Group.

May 10

Buffalo Rubber Group, and Ontario Rubber Section, CIC. International Meeting. General Brock Hotel, Niagara Falls, Ont., Canada.

May 14-16

Armour Research Foundation and *Nucleonics Magazine* Second Annual Industrial Nuclear Technology Conference. Museum of Science & Industry, Chicago, Ill.

May 15

Washington Rubber Group. Pepco Auditorium, Washington, D. C.

May 15-17

Division of Rubber Chemistry, ACS, and Rubber Division, CIC. Joint Meeting. Sheraton-Mt. Royal Hotel, Montreal, P.Q., Canada.

May 20-23

Design Engineering Show; Conference of Machine Design Division, ASME. Coliseum, New York, N. Y.

May 21

Elastomer & Plastics Group, Northeastern Section, ACS. Annual "Short Talk" Symposium.

May 22-24

American Society for Quality Control. Eleventh Annual Convention and Exposition. Masonic Temple, Detroit, Mich.

May 24

Connecticut Rubber Group.

June 1

Southern Ohio Rubber Group.

June 6

New York Rubber Group. Outing. Doerr's Grove, Millburn, N. Y.

June 7

Fort Wayne Rubber & Plastics Group. Outing. Lake Tippecanoe, Leesburg, Ind.

June 7-9

The Los Angeles Rubber Group, Inc. Summer Outing. Sahara Hotel, Las Vegas, Nev.

June 9-13

American Society of Mechanical Engineers. Semi-Annual Meeting. Sheraton Palace Hotel, San Francisco, Calif.

June 11

Buffalo Rubber Group. Outing.

June 14

Boston Rubber Group. Outing. Andover Country Club, Andover, Mass.

June 21

Akron Rubber Group. Outing. Firestone Country Club.

June 28

Detroit Rubber & Plastics Group, Inc. Outing.

August 1

New York Rubber Group. Golf Outing. Baltusrol Golf Club, Springfield, N. J.

September 11-13

Division of Rubber Chemistry, ACS. Hotel Commodore, New York, N. Y.

September 18-20

National Bureau of Standards, Catholic University of America, Applied Physics Laboratory of Johns Hopkins University. Symposium—"Formation and Stabilization of Free Radicals." National Bureau of Standards, Washington, D. C.

September 23-25

American Society of Mechanical Engineers. Fall Meeting. Hotel Statler, Hartford, Conn.

News from Abroad

France

Belt Sheeting from Latex

The direct use of latex in the manufacture of belting has been considered for some time, but not until recently, when methods were developed for improving the adhesion between textile fibers and latex rubber, had any real headway been made. Success with the manufacture of transmission belts directly from latex on an industrial scale in France has encouraged efforts to manufacture conveyor belting also. At the Institut Français du Caoutchouc a system has been devised by which latex sheets designed to be vulcanized to belting plies can be produced.

The experimental machine built for the purpose of preparing these sheets consists essentially of an aluminum cylinder about 20 inches in diameter with an embossed or profile surface, and an endless metal band, which passes over and makes contact with the surface of the cylinder. The metal band passes over four smaller cylinders or rolls, one of which regulates the tensions of the band, thus insuring that it fits over the embossed cylinder. The lower part of the main cylinder dips into a tank of water heated by gas jets.

A thermosensitive latex compound is fed by gravity from a funnel through a tube and under the metal band and into the space between the embossed cylinder and the metal band. The surface of the cylinder and the band pass through the tank of hot water where the latex gells, and the sheet is formed. Further drying is accomplished after the sheet leaves the machine. Careful control of temperature is essential for the success of the process.

The experimental machine produced about 60 meters of latex sheet per hour. It was found that the device could also be used as a profile calender for latex sheets for other purposes, including those made from foamed latex. It was suggested that the apparatus might be used on plantations for the continuous production of latex sheets from heat-sensitized latex compounds.

Record Activity '56 Half

The French rubber goods manufacturing industry as a whole used more rubber in the first half of 1956 than in the corresponding period of 1955, French sources reveal, with the totals, including natural and synthetic rubber and latices as well as reclaim, amounting to 98,598 and 90,105 metric tons, respectively. As in 1955, the share of the tire industry (55,194 in 1956, against 50,383 metric tons) came very close to 56% of the total; while general rubber goods (43,404, against 39,722 tons) made up the remaining 44%.

Judging by the figures for general rubber goods, the highest rate of increase in production under this head was in flooring and sponge and cellular rubber goods, and relatively the biggest drop in output was in heels and soles and crepe soling.

The increased consumption in the tire industry was almost entirely accounted for by tires for motor vehicles; cycle tire output required practically the same amount of rubber as in the 1955 period; but inner tubes for motor vehicle and cycle tires took less, as also did airplane tires.

The following table shows the consumption in metric tons for some of the more important items:

	January-June	
	1956	1955
Tires for motor vehicles	44,310	39,552
Tubes for motor vehicles	3,703	3,791
Airplane tires	154	236
Cycle tires	3,362	3,321
Tubes	709	815
Rubberized fabric	1,304	1,365
Tubing and hose	2,483	2,480
Belting	2,490	2,269
Carpet and flooring	2,466	1,664
Sponge and cellular rubber	4,998	3,527
Footwear	5,846	5,448
Crepe soling	1,941	2,196
Heels and soles	3,575	3,910
Toys and sporting goods	659	594
Surgical and sanitary goods	854	743
Mechanicals	8,576	7,743
Electric cables	3,026	3,205
Artificial leather	1,017	874

The French tire industry has been making very rapid strides in recent years. It is calculated that with 1938 as the base year, at 100, the index of production rose to 185 in 1953, 221 in 1954, 234 in 1955, and to more than 270 during the first five months of 1956. The latter figure is likely to be exceeded before long in view of the fact that leading tire manufacturers, including Michelin, Dunlop, and Englebert, are embarked on projects for increasing their facilities.

Rubber Worker Courses

To meet the constantly growing need of greater technical knowledge among personnel at all occupational levels in rubber factories, the French National Association of the Rubber, Plastics & Allied Industries has initiated a course of technical training for rubber workers. A four-year program has been worked out starting with a one-year elementary course for young men at least 17 years old having the necessary industrial school preparation or equivalent. This preliminary education is followed by a one-year orientation course, and a two-year course which leads to a technical diploma.

Enrollment for the elementary course will be free to qualified applicants who have only to obtain their employer's permission, and to submit copies of school certificates or diplomas, and a card showing civic status.

Indonesia

Reports of CPV, 1955

The activities of the Experiment Station of CPV (Central Association of Experiment Stations) were seriously hampered in 1955 by the shortage of scientifically trained European personnel. Following the resignation of one scientist in 1954, four more vacancies occurred in 1955, which had not been filled by the end of the year; in addition, purchase of apparatus, chemicals, and glassware for the laboratories and the acquisition of new scientific works for the library were made very difficult by the many restrictive government regulations.

The Experiment Station served 490 rubber estates in Java and South Sumatra with a total planted area of 215,000 hectares (hectare = about 2.45 acres). The decline in productivity on rubber estates which started in 1953 continued in 1955; overall average yields per hectare dropped from 640 to 582 kilograms, with lowest output levels in East and West Java. Through the aid of Malaya, CPV acquired 25 clones resistant to South American leaf disease; these clones are low yielders and only suitable for top-budding in three-component trees, and for selection purposes, but it was expected to be able to obtain more recent, higher-yielding disease-resistant clones from the United States Department of Agriculture, at Beltsville, Md.

Productivity tests on various local clones revealed the exceptional capacity of clone WR. 101, which gave almost 2,800 kilograms per hectare in its thirteenth year, that is, about 2,500 pounds per acre.

New investigations on a hitherto little publicized budding technique for *Hevea* with so-called Juvenile Type (J.T.) buddings may have important results. J.T. buddings are obtained when the buds used are taken from the stem of seedlings about 1½ years old. The method is not new; the oldest experiments in which J.T. buddings were employed goes back to 1927; the work met with little enthusiasm until 1940 when several experiments were laid out; but unfortunately these were largely destroyed during the war. Renewed interest is now being shown in the J.T. buddings because of the advantages they seem to offer. In several respects they are more like seedlings than normal mature type (M.T.) buddings, for instance in regard to their bark, and their form, which is more conic than that of M.T. buddings; indeed because the union with the stock is so smooth after a few years, J.T. buddings can be mistaken for seedlings in appearance. But most important of all, they grow more rapidly than M.T. bud-

233

BEST IN TRANSPARENT RUBBER, TOO

Hi-Sil®



Interest has increased greatly during recent months in transparent rubber stocks for "crepe" soling and other specialty molded goods.

Columbia-Southern anticipated this interest years ago and set up an extensive research project in the transparent rubber field. The results are now published (*Rubber Age,* January 1957) and will soon be reprinted in our technical bulletin series. If you are not on our regular mailing list, you may reserve a copy by addressing Room 1929W at Pittsburgh or any of our district sales offices.

Tests indicate Hi-Sil 233 to be the best available reinforcing pigment for transparent applications. Commercial stocks with an excellent level of physicals can be produced as transparent compounds with this specific reinforcing silica.

Loadings as high as 97.5 parts (50 volumes) still give excellent transparency in PLIOFLEX* 1778, a new oil-extended polymer. This stock will whiten when flexed, but aptly demonstrates the limits that can be reached. Reducing the pigment loading in PLIOFLEX 1778 to 40 volumes (78 parts) results in a useful compound of middle 80 Durometer hardness. At lower loading levels, other GR-S types are suitable.

A serious investigation of color in transparent compounds was beyond the scope of this work. However, preliminary efforts showed that production of colored stocks is completely practical.

Technologists and others who may be intrigued by transparent rubber possibilities are invited to contact us today for more information.

*PLIOFLEX—TM, The Goodyear Tire & Rubber Co.

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Commercial Chemicals Division

dings, almost as rapidly as seedlings in fact.

Investigations now are being directed toward establishing the extent of the differences between the two types of buddings and the conditions under which they arise; also the height at which stem buds yield J.T. buddings, and at what age of the seedling, and finally whether the Juvenile phase can be fixed.

According to the report, Indonesia produced about 13,000 T.C. rubber in 1955, of which about 12,000 tons came from estates served by CPV. It is noted, however, that since no premium is paid on T.C. rubber and its preparation involves extra costs, interest is declining. The total output of T.C. rubber in southeast Asia in 1955 came to 67,416 tons, an increase of 6,000 tons over 1954 output. Malaya's share was about 37,000 tons, and that of Viet-Nam and Cambodia, roughly 17,000 tons.

In connection with the falling output of rubber on estates, CPV is undertaking an inquiry, and members are to be circularized in an effort to discover the factors contributing toward this situation. Companies are being asked to supply data on yields, climate, soil and planting conditions, and tapping systems.

Malaya

High-Yielding Material

The January 1957, issue of the *Planters' Bulletin*, of the Rubber Research Institute of Malaya, with its editorial on "High-Yielding Material," arrived just in time to provide information that seems to answer Mr. Wong's statements on replanting.

The editorial cites data compiled by the Department of Statistics, Federation of Malaya, and appearing in the "Rubber Statistics Handbook for 1955."

Malaya (Federation and Singapore) has 3,500,000 acres under rubber, of which 2,025,000 acres are on estates of 100 acres and over. During 1955, some 1,610,000 acres on estates in regular tapping produced 353,000 tons of rubber, which comes to an average for the whole of 490 pounds per tapped acre per annum. The yields from known high-yielding material and known unselected seedlings were listed separately, and it was found that 1,012,000 acres of known unselected seedlings produced 160,000 tons of rubber in 1955, or 355 pounds per acre, per annum; whereas 446,000 acres of the known high-yielding material also yielded 160,000 tons, or at the rate of 806 pounds per acre per annum.

Further analysis of the 446,000 acres of known high-yielding rubber revealed that 207,000 acres gave 60,000 tons, or 650 pounds per acre, per annum; while 239,000 acres produced 100,000 tons, or a mean of 940 pounds. It is assumed that the 650 pounds per acre came from older areas planted with clones and clonal seedlings which are no longer used; whereas the 940 pounds came from newer clones. Accordingly, the material may be classified as, unselected seedlings, yielding 355 pounds per acre; older high-yielding material, 650 pounds; and newer high-yielding material, 940 pounds per acre per annum.

But there is scope for still further improvement in yields. The RRI has obtained annual yields of 1,500 to 2,100 pounds per acre in large-scale field trials over 10 years' continuous tapping on the standard half-circumference alternate-day system. The same clones have yielded 1,200 to 1,600 pounds per acre, per annum, in a number of similar large-scale trials on good estates. "The Rubber Statistics Handbook, 1955," mentions that in normal commercial plantings the highest yielding areas—57,000 acres on 200 estates, which produced 29,000 tons—gave an average of just over 1,100 pounds per acre.

The editorial concludes with the advice that tapping routine will have to be reorganized to insure that the high-yielding material is exploited to best advantage.

Lower Rubber Price a Must

The Association of the Chinese Chamber of Commerce in Singapore now states that the way to get Americans to buy more natural rubber is not by predicting the ruin of Malayan economy and the "collapse of democracy's bulwark in South East Asia" if Americans did not do so, but by attempting to meet the synthetic rubber price. To this end costs must be lowered.

In his annual review for 1956, the Association's secretary, Henry Wong, considered how this result is to be achieved. Large-scale replanting with high-yielding material, as urged by many, is not the solution, since even if by some miracle, output were doubled overnight, production costs would still be too high to meet the current price of 23¢ (American) per pound for synthetic rubber. Wages for labor account for 65% of total cost of production; but the pay labor gets is barely enough to provide essentials because of the high cost of living—and the cost of living is high because of the custom tariff.

The government's position is that the tariff is a necessary evil, which, however, does not affect the masses of the people to any great extent; but the masses, Mr. Wong said, hold that the tariff can be lowered if government reduces growing administration expenditure. In conclusion, Mr. Wong warns that whatever the merits of the opposing claims, the important thing is to do something for natural rubber before it is too late.

Blackman Report Secret

A secret report on the position of natural ruber in Malaya has been submitted to the Rubber Producers' Council by Prof. G. E. Blackman, who with two other scientists, visited Malaya in July, 1956, to study the problem of the Malayan rubber industry in competition with synthetic rubber.

The report arrived early in January, but so far nothing has been published about it to the impatience of the local press and apparently, also, of RRI members. Some members of the Institute are understood to be resigning this year, and others are reportedly awaiting the facts of the report before coming to a decision whether to do likewise.

Ask Packing and Shipping Ordinance Repeal

The Rubber Trade Association of Singapore, jointly with the Chinese Chamber of Commerce, continues to insist on the abolition of the Rubber Packing and Shipping Ordinance and has framed an appeal to this effect to the government.

In addition, the proposal has come from Heah Joo Seong, president of the Federation of Rubber Trade Associations, Penang, that Malaya should appoint and station two representatives in London and New York to investigate buyers' claims on the spot. Mr. Heah said that since the introduction of the ordinance, conditions had improved remarkably, with only a small number of claims by American importers, but that London buyers tended to make many "frivolous" claims.

The Singapore men, it may be noted, find, however, that New York buyers also make many unreasonable claims.

The London rubber dealers, Sanderson & Co., (Rubber), Ltd., dealing with these matters in a recent circular, said that it was time for some plain speaking before further damage was done by this campaign. To be sure, many claims for inferior quality were sustained, and the allowances were sometimes justifiably large. But the basic cause of the situation was not in London, but in the quality of the goods shipped; the proportion of off-grades arriving below the standard contracted for was too high, the circular said. It then went on to show that off-quality prices in Malaya were determined by destination. Parcels were offered on the London market with restrictions as to where they might or might not be sold. Similar off-grades bought in Malaya cost more if required for New York than for other destinations because the New York market was known for strict judgment of quality.

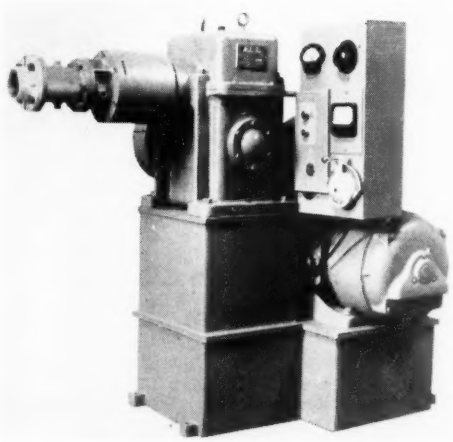
European estate producers selling in the London market were rarely reluctant to sell in any market, for the reason that quality was properly graded, the circular declared. The fact that it was found necessary to institute the Malayan Rubber Export Registration Board, it concluded, was proof that very much still had to be done to improve the packing industry.

Assurance to Investors

"I take this opportunity to assure those who now have capital in the industry, as well as those who intend to invest in Malaya, that the government will do everything in its power to protect their interests.

(*Continued on page 956*)

NEW EQUIPMENT



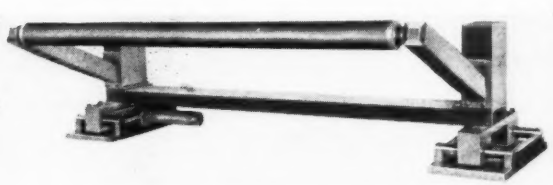
Rolis two-inch extruder

Rolis Rubber Extruder

A rubber extruder featuring a one-piece, heavy-walled jacketed steel cylinder with removable Xaloy liner has been placed on the market by Rolis, Inc., Brooklyn, N. Y. The extruder, reduction unit, and motor are mounted on a one-piece steel base for stability. Other features are reported to include a jacketed hopper with undercut for ease of strip-feeding, heavy-duty gear reduction unit, speed indicator, electrically heated die holder with heat indicator and controller, simplified gravity feed lubrication, a rotary union for heating or cooling of screw, a hinge-type swing head, and a precision ground cored feed screw. About four-feet-high, the machine requires a floor space of three by five feet. The extruder is available in sizes ranging from one-inch to 4½ inches.

Automatic Shiftable Cradles for Unwinds

A line of shiftable cradles for automatically guiding materials from an unwind or let-off is being offered by Fife Mfg. Co., Oklahoma City, Okla. The Fife cradle is designed to utilize existing backstands and/or journals, shaft, and brake or tensioning devices. According to the company, most applications are made by removing these items from the machine and mounting them intact to the cradle which is then mounted directly to the frame of the machine or to the floor. An idler roller, whose position is customized, is integrally attached to each cradle. The Fife cradles can be used with the company's pneumo-hydraulic web guide power units for guiding from the unwind into any type of web-fed operation.



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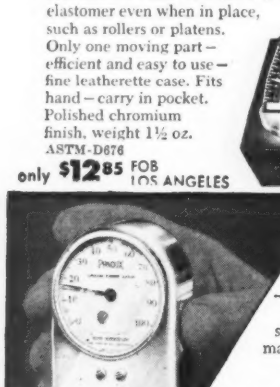
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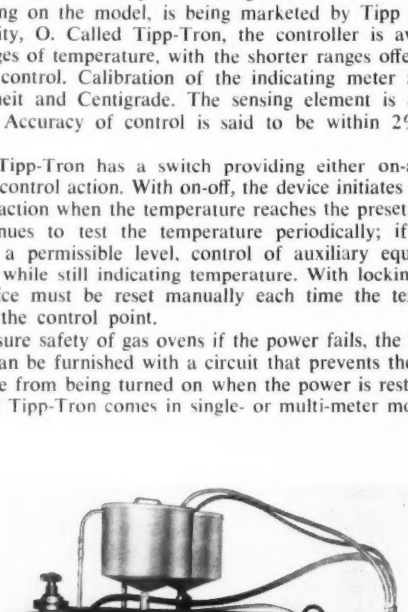
Tipp-Tron automatic thermal control

Tipp Temperature Controllers

A line of industrial and research temperature control instruments that covers a temperature range from — 200 to 3,000° F., depending on the model, is being marketed by Tipp Mfg. Co., Tipp City, O. Called Tipp-Tron, the controller is available in ten ranges of temperature, with the shorter ranges offering more precise control. Calibration of the indicating meter is in both Fahrenheit and Centigrade. The sensing element is a thermocouple. Accuracy of control is said to be within 2% of dial settings.

The Tipp-Tron has a switch providing either on-and-off or locking control action. With on-off, the device initiates its desired control action when the temperature reaches the preset limit, but it continues to test the temperature periodically; if the heat reaches a permissible level, control of auxiliary equipment is stopped while still indicating temperature. With locking control, the device must be reset manually each time the temperature reaches the control point.

To insure safety of gas ovens if the power fails, the Tipp controller can be furnished with a circuit that prevents the solenoid gas valve from being turned on when the power is restored. The standard Tipp-Tron comes in single- or multi-meter models.



Klauder Williams Foam Master

Rigid, Flexible Polyurethane Foam Machine

A machine for making both rigid and flexible polyurethane foams has been introduced by Klauder Williams Co., Philadelphia, Pa. Called Foam Master, it can be set to produce

(*Continued on page 948*)

NEW MATERIALS

HMDA-Carbamate Vulcanizing Agent

A new vulcanizing agent which permits the controlled curing of elastomers and resins capable of being cross-linked with organic polyamines has been introduced by the chemical manufacturing division of M. W. Kellogg Co., Jersey City, N. J. Called HMDA-Carbamate, it is an inner salt of hexamethylene diamine, a free-flowing white powder which is readily soluble in water, but insoluble in non-polar solvents. It was first developed for use in vulcanizing the company's Kel-F Elastomer, but is said to show promise as an efficient curative for other rubbers of the reactive halogen or acrylic ester type.

According to Kellogg, one of the primary advantages of the new vulcanizing agent is that of controlled reactivity, with the normally active amine groups shielded until curative and polymer are thoroughly mixed. This shielding minimizes premature reactions due to localized, high concentrations of the curative during early stages of mixing. The effect is a more uniform distribution of cross-links between elastomer molecules, the company says.

Thermocuring Pliobond H. T. Adhesive

A thermocuring adhesive designed for high-temperature applications has been added to the adhesive line of The Goodyear Tire & Rubber Co., chemical division, Akron, O. Called Pliobond H. T., it is a one-part adhesive containing 20% solids and generally resembles the company's regular Pliobond resin-elastomer adhesive. Pliobond H. T. cures at a temperature of about 350° F. A recommended cure is 300-400° F. for 15 minutes and under a pressure of from 50 psi. for soft materials, up to higher pressures for harder materials.

The major advantage of Pliobond H. T. is that it does not creep under load at high temperatures, Goodyear reports. A secondary advantage is said to be its marked retention of flexibility at temperatures throughout its serviceable range. Still developing applications for the new adhesive, Goodyear is optimistic about its potential mechanical and electronic uses.

Nuclear Reactor Coolant-Moderator

Pilot-plant quantities of isopropylbiphenyl, reported to offer economic advantages as a coolant-moderator for nuclear reactors, are being offered by Monsanto Chemical Co., organic chemicals division, St. Louis, Mo. A derivative of biphenyl, the water-white liquid is said to be better as a coolant-moderator than water, which requires expensive, corrosion-resistant materials such as stainless steel plus a system that will withstand high pressures. With isopropylbiphenyl, corrosion of the system does not occur, and decomposition products can be separated by simple distillation.

Other applications of the organic chemical are as a heat exchanger, chemical intermediate, and dielectric.

Some typical reported properties of isopropylbiphenyl are as follows:

Molecular weight	196.3
Specific gravity @ 25° C.	0.979
Refractive index, n_D^{25}	1.5808
Vapor pressure @ 295–300° C., mm. Hg.	760
Flash point	139° C.
Fire point	152° C.
Pour point	−54° C.
Viscosity @ 100° F., centistokes	4.655
Dielectric strength (60 cycles, 0.1-inch gap)	48 KV

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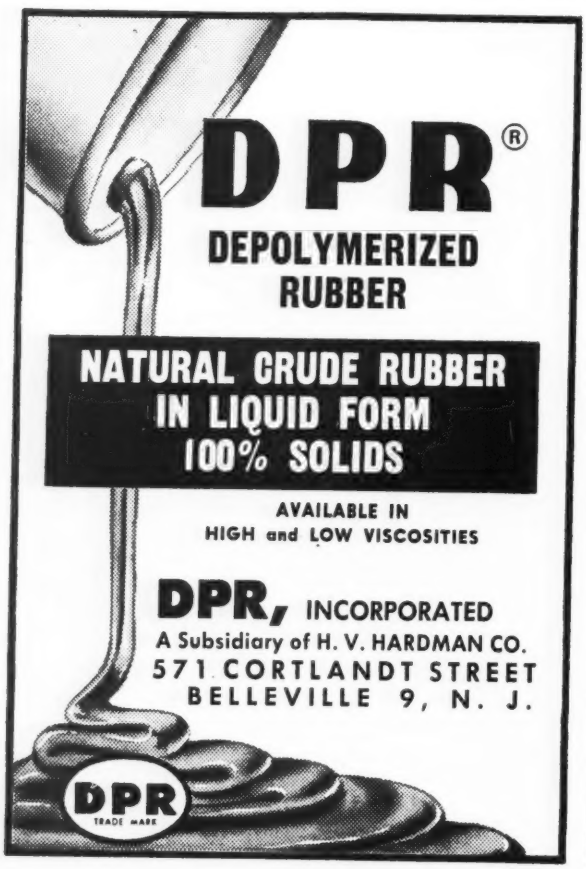
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Emery 3049-S Polymeric Plasticizer

A new high-molecular-weight polyester plasticizer that is said to permit easy processing on conventional equipment has been introduced by Emery Industries, Inc., Cincinnati, O. Designated Emery 3049-S, it is said to function as a primary plasticizer for polyvinyl chloride polymers and copolymers and is expected to find additional application in synthetic rubbers, nitro-cellulose, ethyl-cellulose, and cellulose acetate butyrate resins.

Such high-molecular-weight characteristics as very low migration, excellent resistance to extraction, low volatility, and good electrical properties are inherent in 3049-S, the company reports; while its viscosity and wetting qualities make it an excellent plasticizer for dispersions and pigment coatings.

Suggested applications of the plasticizer include infants' accessories, commercial tapes, oil- and gasoline-resistant upholstery, gasketing, coatings on rubber and latex-impregnated paper, and polyethylene jacketing.

Light in color, 3049-S has a viscosity @ 25° C. of 550-650 poises.

Development Product Bulletin No. 62, "Emery 3049-S Polymeric Plasticizer," describing the plasticizer in detail and giving its performance properties in Geon 101, is available from the company.

Poly-Tergent G-300 Surfactant

A liquid, anhydrous, non-ionic surface active agent. Poly-Tergent G-300 has been introduced by Olin Mathieson Chemical Corp., New York, N. Y., as one of a four-member Poly-Tergent line. Chemically, G-300 is an alkyl phenol polyglycol ether, designed to possess good wetting, emulsifying, and detergent properties, according to the company. It is particularly recommended for wetting and suspending such materials as clay, pigments, carbon black, and red iron oxide. Its ability to disperse lime soaps, such as calcium oleate, is called outstanding. Based on weight of soap, only 6-8% of G-300 is said to be enough to suspend the insoluble soap formed in water of any hardness.

Some reported physical and chemical properties of the pale yellow, slightly aromatic liquid are as follows:

Specific gravity @ 25° C.	1.05–1.06
Viscosity @ 25° C., Cps.	280–300
Cloud point (1% aq. sol.), °C.	62–70
Softening point, °C.	0–5
Flash point, °C.	280–290
pH of 1% aqueous solution	neutral

Polyurethane Foam Machine

(Continued from page 946)

polyurethane foams with a wide range of properties and will be made available in various capacities from large-production models to small portable units for pattern and development molding.

The components are placed into separate tanks above the top of the machine and gravity-fed to the pumps. The positive displacement pumps are driven by variable-speed drives which permit exact proportioning of the basic components prior to entering the mixing head. Additional mixing is not required after the exothermically released CO_2 has been given off. The discharge at the mixing head may be mounted on extension lines for foamed-in-place operation.

The various elements of the Foam Master are mounted in a cabinet-type aluminum housing with welded steel frame. Fluid lines from tanks to pumps are rigid stainless steel; while others are flexible and fitted with leakproof snap-on couplings for quick detachment and reassembly after cleaning. Three-way valves are provided at the mixing head for better production control and to eliminate waste of raw materials by recirculating during mold swingovers. Motors and control switches are explosion-proof (ULA-approved). The current production model of the Foam Master requires a floor space of 48 by 54 inches, is 52 inches high, and weighs 750 pounds and will produce up to 8 pounds per minute of foam, depending on the formulation.

NEW PRODUCTS

Thorobred Mobile Home Low-Boy Tire

A new medium-height tubeless tire has been added to the mobile home tire line of The Dayton Rubber Co., Dayton, O. Dubbed Thorobred Mobile Home Low-Boy, the tire is 7.00 x 14.5, 3.2 inches less in height than the conventional 7.00 x 15 size. The tire is said to have a high load capacity for accommodating heavier and wider coaches. Dayton now claims to be the first major manufacturer to offer a complete line of mobile home tires.

New Goodyear Vinyl Flooring Whites

The Goodyear Tire & Rubber Co., Akron, O., has expanded the number of color combinations in its marbleized vinyl flooring line to 26 with the addition of three new light-value whites—Grenada, Antiqua, and Riviera. Produced by mottling of pastels within a basic white background, the new whites are available in standard, deluxe, and super-deluxe vinyl flooring grades. Standard and deluxe are available in 0.080-gage; super-deluxe in $\frac{3}{32}$- and $\frac{1}{8}$-inch gage.

U. S. Royal Seniors Golf Ball

A golf ball that will "give the easy-swinging golfer faster get-away and longer distance" has been placed on the market by United States Rubber Co., New York, N. Y. Called U. S. Royal Seniors, the golf ball has a liquid-silicone center, a hard-cured pure rubber thread winding, and a Cadwell cover. Available in diamond or dimple cover marking, the golf ball is said to meet all the required specifications of the United States Golf Association.

Nylon-Reinforced Plastic Wheel

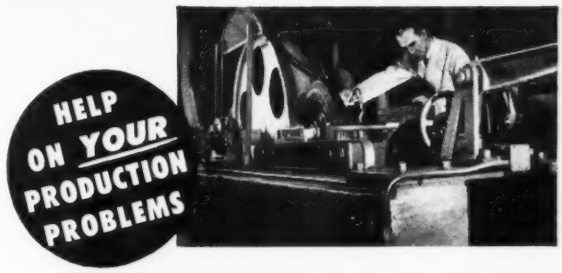


"Lamilon" Wheel

What is called the first reinforced all-plastic industrial wheel ever introduced is being marketed by The Fairbanks Co., New York, N. Y. Called "Lamilon" Wheel, the nylon-reinforced wheel is said to have exceptionally high impact strength and abrasion resistance, characteristics which enable it to maintain its smooth tread, thereby protecting floors against marring. Although it does not reveal the type of plastic used, the company says it has a water absorption factor almost as low as high-quality rubber, is unaffected by oils and greases, shows a high resistance to acids, alkalies, and solvents, and will, moreover, out perform all but metal wherever temperature is a factor.

"Lamilon" wheels are also sparkproof and have high load ratings, according to Fairbanks. The wheels, available in sizes 3-12 inches, have alloy steel roller bearings and provision for pressure lubrication.

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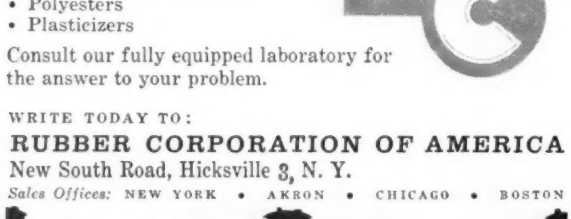
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TECHNICAL BOOKS

BOOK REVIEWS

"Organic Chemistry." Third Edition. Louis F. and Mary Fieser. Reinhold Publishing Corp., New York, N. Y. Cloth cover, 6 by 9 inches, 1112 pages. Price $10.

The Fiesers' "Organic Chemistry" is without doubt one of the best reference books in the broad field of organic chemistry available today. Its 40 chapters and thousand-odd pages of text touch on nearly every aspect of organic chemistry and delve deeply into some. Since it is so valuable in this respect, it is perhaps unfortunate that it suffers somewhat from too much effort to be "all things to all men."

As might be expected, the greatest changes in the third edition, as compared with the second, are in the fields of the authors' greatest interest. The chapters dealing with natural products and their metabolism have been thoroughly revised, and this material is no doubt as excellent a statement of up-to-date knowledge in these complex fields as can be found anywhere.

Fairly extensive changes have also been made to provide a volume more suitable as a textbook. More electronic theory has been incorporated, and the concepts of resonance and molecular orbitals are introduced at an early point. The expansion of the question sections at the end of chapters and the addition of answers at the end of the book are also very worthwhile aids for the student. The authors' preoccupation with bench work is again evident throughout in the many illustrations and details of experimental procedures.

In spite of all this the volume seems on the formidable side when considered as an elementary textbook. It does seem that the text would be more serviceable if it were arranged with the elementary material in one place, or even split into two volumes.

The basic chemical material appears in general to be well chosen, although in today's technology devoting 65 pages to dyes as compared with 10 to acetylenic compounds and one to mercaptans might be questioned.

The space devoted to rubber has been decreased by a factor of about 50% as compared with the second edition. Also, the three chapters which dealt with high polymers in the second edition have been merged into one. This procedure is very reasonable in a book of this type, but it does appear that some of the material might have been better chosen. There are at least ten errors, mostly of minor nature, either stated or implied in the section on rubber, a fact which shakes the reader's confidence in the details of other sections of this general type. It is unfortunate that no mention is made of polyurethane rubbers or for that matter of polyisocyanates despite the fact that they are rapidly attaining commercial importance and also involve some interesting chemistry.

The polymers based on fluorinated hydrocarbons are also given rather cursory attention with ten lines used for polytetrafluoroethylene, but with no mention of other fluorinated plastics or elastomers, or the changing technology which makes them of such interest. Again these are minor factors when the book is considered as a whole; they do assume more importance when the third edition is considered on its merits as compared with the second. The Ziegler-Natta directed polymerization techniques are discussed.

In summary, this third edition of "Organic Chemistry" appears invaluable to workers in the fields of natural products and their metabolism. As a general organic reference book, it maintains the high standards of previous editions, but does not emphasize the new developments of the past six years to such an extent as to make it of markedly greater value than the second edition as a source of new material. To those of us in the rubber industry the third edition is mildly disappointing, not because of the reduced space devoted to high polymers, but because of evidence of some inaccuracies.

R. W. BROWN

"Creative Communication." Edward Laird Cady. Reinhold Publishing Corp., New York, N. Y. Cloth cover, 4¾ inches by 7 inches. 164 pages. Price $2.50.

The author, a management consultant, believes that the need of communicating is growing with the continued industrialization of our economy. His small, well-written book is intended for both the professional communicator, such as the public relations man, and the non-professional communicator, such as the plant executive, the researcher, and the work supervisor.

Short summaries of the salient points of each chapter and exercises at the end of each chapter help the reader obtain maximum benefit from this book. Anyone who may need to write a communication—memorandum, formal report, manual, advertisement, press release—can profit from this book.

NEW PUBLICATIONS

"Series 700 Multiple Knife Cutters." Index No. App. 210. Taylor, Stiles & Co., Riegelsville, N. J. 4 pages. The firm's Series 700 plastic pelleters, which have a capacity of ten tons of cut pellets an hour, are described and illustrated in this folder.

"Good-rite Plasticizers." Service Bulletin GP-8. B. F. Goodrich Chemical Co., Cleveland, O. 20 pages. Specifications and typical performance data of the company's plasticizers for polyvinyl chloride resins, together with sample recipes, are presented in this illustrated booklet. A discussion of Hycar 1312 in vinyl plastisol compounding is included.

"Coumarin." Monsanto Chemical Co., organic chemicals division, St. Louis, Mo. Specifications and solubility tables for the company's coumarin, used as a masking agent for latex cement and other latex products and for odor masking in the manufacture of plastics and varnishes, are included in this little folder.

"Harwick Clays in Rubber." Bulletin #01-13-1-12-56. Harwick Standard Chemical Co., Akron, O. 2 pages. The specifications and typical analyses of the company's six water-fractionated clays in various colors, surface treatments, and particle sizes appear in this publication, together with comparative physical properties and cure rates of competitive products.

"Plaskon Nylon Molding Compound." Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. 8 pages. The properties and applications of Plaskon 8200 nylon molding compound are discussed in this booklet.

"The Control of Insulated Wire Diameter." Industrial Gauges Corp., West Englewood, N. J. 4 pages. This is a reprint of a paper presented at the 1956 annual convention of the Wire Association. The authors are C. M. Frederickson, Kaiser Aluminum & Chemical Corp., and C. D. Gibbs, Industrial Gauges.

"Acushnet Silicone Compounds." Acushnet Process Co., New Bedford, Mass. 12 pages. Physical properties of the company's heat-resistant and low-shrinkage silicone compounds and silicone resin molding compound and the products it manufactures from them are included in this illustrated brochure. The firm's custom compounding service is also explained.

"Modulus of Nitrile Rubber Compounds Containing Hi-Sil." Hi-Sil Bulletin No. 11. Columbia-Southern Chemical Corp., Pittsburgh, Pa. 7 pages. The modulus of Hi-Sil 233-loaded rubber compounds can be made equal to or higher than that of Hi-Sil 101-loaded nitrile rubber compounds by reducing the ester plasticizer, by increasing Hi-Sil 233 loading slightly, by increasing TMTDS accelerator slightly, or by using accelerator-activators such as magnesium oxide, litharge, or Dibenzo GMF. According to this report, all of the 233-loaded compounds have very much higher tensile strength and tear resistance than 101-loaded stocks.

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Reprints for Sale

The following reprints of the very popular and informative articles which appeared recently in RUBBER WORLD may be had at the prices indicated:

GR-S Type Synthetic Rubber—Present and Possible Future Trends. By R. G. Seaman. **50¢** each.

Accelerators Curing Systems. Akron Rubber Group Symposium and Panel Discussion. **35¢** each.

"Rubber Railroads." By F. W. Blanchard. **25¢** each.

Rubber Meets the Challenge of Modern Transportation. Akron Rubber Group Symposium and Panel Discussion. **35¢** each.

Ozone Cracking of Natural and Synthetic Rubbers. By James E. Gaughan. **35¢** each.

Rhode Island Rubber Club Panel Discussion on Butyl Rubber. **35¢** each.

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"Paints, Emulsions, and Coatings." Philip Carey Mfg. Co., Lockland, Cincinnati, O. Eight of the company's roofing and damp-roofing products for maintaining and repair purposes are described in this illustrated folder.

"Columbian Carbons—Beaded for Better Bulk Handling." Columbian Carbon Co., New York, N. Y. 24 pages. Carbon black bulk-handling methods and equipment, with particular reference to beads, are discussed in this illustrated booklet. Tentative ASTM test methods are also given. A typical bulk handling system arranged as in actual installation is sketched and described.

"Care and Feeding of Rubber Rolls." Report No. 11. Rodney Hunt Machine Co., industrial roll division, Orange, Mass. 2 pages. The maintenance of rubber rolls is the subject of this report. Common troubles and treatments are listed.

"How to Mount and Demount Tubeless Tires on New-Type 14" and 15" Rims." The Rubber Manufacturers Association, Inc., New York, N. Y. 1 page. These instructions are illustrated.

"Unitex Centrifuged Natural *Hevea* Latex." Stein, Hall & Co., Inc., latex and rubber department, New York, N. Y. 20 pages. The production of the company-distributed latex in British Malaya is described in this illustrated booklet. Specifications of Unitex latex are given.

Publications of M. W. Kellogg Co., chemical manufacturing division, Jersey City, N. J.:

"Kel-F Elastomer—Properties, Applications." 16 pages. The gum and vulcanizate properties, fabrication, and applications of Kel-F fluorocarbon rubber are discussed in this illustrated booklet. Sample recipes and test data are included.

"Kel-F Elastomer—Compounding, Vulcanization, Fabrication." 12 pages. This illustrated booklet is specifically designed to acquaint the rubber fabricator with techniques of compound, vulcanization, and fabrication as they refer to Kel-F Elastomer.

Publications of E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington, Del.:

"Neoprene Type WHV." J. F. Hagman and M. A. Schoenbeck. Report No. 57-1. 20 pages. The properties, compounding, and applications of Neoprene Type WHV, which is chemically similar to Type W, but has a much higher viscosity, are discussed in this technical report. Types WHV recipes for a wide variety of goods are included.

"Neoprene Latex Type 635." R. O. Becker. Report No. 57-2. 8 pages. A creamed form of Neoprene Latex Type 735, Type 635 can be combined with other neoprene latices to produce dip and foam compounds said to have better wet gel strength and improved adhesive formulations without the penalty of solids reduction of the compounds. The latex is especially designed for producing films of high strength and elongation immediately upon gelation of the latex. The report gives recipes for practical compounds.

Publications of Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.:

"Paracril CLT." W. E. Galwardy. Bulletin No. 211. 8 pages. The physical properties of Paracril CLT, a low-temperature polymerized nitrile rubber which has general application in oil-resistant mechanical goods, as well as in cements and adhesives, are reported in this technical bulletin. Some recipes and test data are included.

"Paracril BJLT." W. E. Galwardy. Bulletin No. 213. 4 pages. Given in this bulletin are the processing and physical properties and test data on Paracril BJLT, a medium oil-resistant, low Mooney viscosity cold nitrile rubber.

"Stauffer Sulfurs." Stauffer Chemical Co., New York, N. Y. 48 pages. Sulfur—its history, geographical distribution, uses, production, and general statistics—is the subject of this extensively illustrated booklet. The company's various grades of sulfur are discussed, and their physical and chemical properties tabulated.

"ASTM Standards on Textile Materials." November, 1956. American Society for Testing Materials, Philadelphia, Pa. Paper cover. 6 by 9 inches. 836 pages. Price, $6.25. The most recent ASTM tentative and standard methods of tests, specifications, and definitions pertaining to textile materials are included in the latest edition of this book. Of the 126 standards and tentatives, 21 are new, and eight were revised. Fourteen appendices cover 13 proposed recommended practices, methods of test, and specifications, as well as a table of the basic properties of textile fibers, a psychrometric table for relative humidity, and the yarn number conversion table. There is an extensive index.

"News-Letter." January, 1957. Rubatex Products, Inc., New York, N. Y. 3 pages. Microcellular shoe soling using cyclized rubber as a reinforcing agent for natural rubber and some thoughts on the use of plasticizers in the manufacture of closed-cell vinyl plastics are the subjects discussed in this issue of the News-Letter.

"Use of Adhesives with Reinforced Plastics." Rubber & Asbestos Corp., Bloomfield N. J. 8 pages. This reprint discusses recent developments in resin adhesives and gives case histories of their use in solving difficult bonding problems. Tables, charts, and diagrams illustrate the survey.

"Fortex A in Low-Cost Compounds." Bulletin FA-16. Thermoid Co., chemical division, Trenton, N. J. 3 pages. Two studies in which the company's Fortex A extender was used to improve the cohesiveness of inexpensive rubber compounds are discussed in this publication.

"Moly-Sulfide as a Filler." Bulletin Lu-12. Climax Molybdenum Co., New York, N. Y. 4 pages. This illustrated publication describes the uses of the company's molybdenum disulfide as a filler in nylon, phenolic laminates, Teflon, and natural and synthetic rubbers. The preparation and properties of the filled products are outlined. The frictional and mechanical properties of the basic materials are said to be improved.

"Application of Paper Chromatography to the Identification of Accelerators and Antioxidants." J. W. H. Zijp. Rubber Research Institute T.N.O., Delft, Holland. 30 pages. In this reprinted paper the difficulties in the identification of accelerators and antioxidants in rubber compounds are reviewed. A detailed procedure for the detection of four guanidine derivatives by paper chromatography is cited, and the identification of diphenyl thiourea and diorthotolyl thiourea described.

"Adhesives and Coatings from Vinyl Ether Polymers and Copolymers." P-123. General Aniline & Film Corp., commercial development department, New York, N. Y. This data sheet discusses the applications of a series of four related polymers in the compounding of new adhesive and coating formulations. The polymers are used to give improved properties with such varied materials as polyvinyl acetate, natural rubber, polystyrene, and polyvinyl chloride.

"Stan-Tone Paste Colors." Bulletin #02-177-5-12-56. Harwick Standard Chemical Co., Akron, O. 2 pages. The company's vinyl organic and inorganic paste colors dispersed in a plasticizer are listed in this bulletin.

Publications of Beacon Chemical Industries, Inc., Cambridge, Mass.:

"Aquazinc KC Concentrate." 2 pages. The company's stable, highly concentrated, dispersible zinc stearate for use as an anti-tack agent on sheeted, mill-room, slab stock, and small molded mechanical rubber items is described in this publication.

"Colite Concentrate." One page. This technical data sheet describes Beacon's concentrated rubber mold lubricant, said to be non-toxic, non-tacky, and odorless.

"Ammonium Stearate." One page. The firm's ammonium stearate, a white, pearly paste with an ammoniacal odor, suggested for use in water-repellent coatings, is described.

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RUBBER WORLD

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MARKET REVIEWS

Natural Rubber

Natural rubber prices continued to fall during the January 16-February 15 period, although not at the accelerated rate of last month. Far Eastern offerings were to a large extent disregarded by American purchasers as a prevailing note of caution set in. This caution resulted from a series of public warnings by political and financial observers that the American economy was not so impregnably sound as was believed and that an inflationary trend was a distinct possibility. These pronouncements were followed by falling prices on the New York stock market. In Detroit, earlier optimism among automobile manufacturers concerning sales possibilities for 1957 was believed to have all but disappeared. Sales were being watched very closely for trends while rubber purchases were being held in abeyance.

While caution prevailed in the United States, heavy offerings were being made in Malaya. Up-country selling and liquidation gained momentum, laying bare the existence of a large stale bull holding by one of the major Chinese operators there. This seemed likely to prove unwieldy and to lead to financial difficulties which might affect not only Singapore, but the other world markets.

Statistically, 37,150 tons of rubber were traded on the New York Commodity Exchange during the January 16-February 15 period, all on the Rex Contract. There were 22 trading days during the period.

Week-end closing Commodity Exchange future prices for the Rex Contract were as follows:

REX CONTRACT

	Jan. 18	Jan. 25	Feb. 1	Feb. 8	Feb. 15
Mar.	31.00	31.80	31.35	30.60	30.50
May	30.90	31.75	30.87	30.35	30.45
July	30.50	30.90	30.57	29.85	30.05
Sept.	30.10	30.60	30.25	29.60	29.80
Nov.	29.80	30.30	29.90	29.40	29.60
1958					
Jan.	29.50	30.05	29.60	29.20	29.40
May	29.25	29.75	29.40	29.00	29.20
Total weekly sales, tons	14,970	8,360	6,460	11,140	3,350

On the physical market, RSS #1 began the period at 33.50¢ a pound, according to Rubber Trade Association sellers' prices, declined to 29.75¢ by February 5, and gained to 30.75¢ on February 15. RSS #1 averaged 31.25¢ a pound during the period, compared to an average of 34.90¢ for the month of January. Average January monthly spot prices for representative grades follow: RSS #3, 32.74¢; #3 Amber Blankets 29.37¢; and Flat Bark, 22.11¢. There were 22 trading days during January.

NEW YORK PHYSICAL MARKET
WEEK-END CLOSING PRICES

	Jan. 18	Jan. 25	Feb. 1	Feb. 8	Feb. 15
RSS #1	31.50	31.50	31.38	30.63	30.75
2	31.25	31.25	31.13	30.38	30.50
3	31.00	31.00	30.88	30.13	30.25
Pale Crepe #1 Thick	39.25	37.75	37.75	37.00	37.00
Thin	38.25	36.75	36.75	36.00	36.00
#3 Amber Blankets	27.50	28.25	28.00	27.25	27.25
Thin Brown Crepe	27.00	27.75	28.00	26.50	26.50
Standard Flat Bark	21.00	20.63	20.75	20.38	20.25

Synthetic Rubber

Both production and consumption of synthetic rubbers in the United States remained at high levels during January, despite some auto manufacturers relaxing their demand for rubber products. This superficially paradoxical situation was brought about by a widespread strengthening of rubber products inventories in the face of threatening strikes in the industry.

Production of all types of synthetic rubbers during January reached a new monthly high of 94,258 long tons, according to estimates of The Rubber Manufacturers Association, Inc. January consumption of all new rubbers was 140,090 long tons, also a record figure; while consumption of synthetic rubber during the same period was 86,680 long tons, compared with December's consumption of 73,278 long tons. January's synthetic-to-natural ratio was 61.87%, slightly higher than December's ratio of 61.84%. The 1956 ratio was 60.90%.

January's exports of synthetic rubbers were substantially below the previous month's. An estimated 20,363 long tons were exported during January, of which 16,500 long tons were SBR. In December, 21,830 long tons were shipped abroad, of which 18,500 long tons were SBR. The general dip in the European economy, a direct result of the Egyptian blockage of the Suez Canal, caused the slackening of demand for synthetic rubbers.

Rumors concerning the introduction of several improved types of SBR have so far not been substantiated. At least one major manufacturer, however, is expected to announce some improved non-staining, oil-extended types within the next few months.

Latex

Falling natural latex prices spurred activity by purchasers during the January 16-February 15 period. The drain on Malayan supplies, for example, was so heavy that one industry source said there was little available now for shipment before May and June. Indonesian supplies were also being strained. The possibility of the devaluation of the rupiah, Indonesia's currency standard, was said already to be bringing about widespread hoarding of stocks. In view of these conditions, a swing upward in natural latex prices is likely during March, barring a further drop in natural rubber prices.

Reports from the synthetic latex market indicate that demand was somewhat higher than last period's.

Prices for ASTM Centrifuged Concentrated natural latex, in tank-car quantities, f.o.b. rail tank cars, ranged during the period from 40 to 45¢ per pound solids. Prices of snythetic latices remained steady at about 26 to 32¢ for SBR; 37-47¢ for neoprene; and 46-54¢ a pound for N-types.

Final November and preliminary December domestic statistics for all latices were reported by the United States Department of Commerce as follows:

(All Figures in Long Tons, Dry Weight)

Type of Latex	Production	Imports	Consumption	Month-End Stocks
Natural				
Nov.	0	4,762	6,431	11,148
Dec.	0	—	6,648	12,064
SBR				
Nov.	6,022	31	5,406	6,282
Dec.	7,101	—	5,781	7,451
Neoprene				
Nov.	886	0	723	1,233
Dec.	967	0	676	1,384
Nitrile				
Nov.	1,175	0	659	1,939
Dec.	1,012	0	597	1,558

Reclaimed Rubber

The reclaimed rubber business showed improvement during the January 16-February 15 period, but activity eased off again soon after. The price of black inner tube was increased 1¢ a pound by one firm, with the rest of the industry expected to follow. The price of first-line whole tire and of fourth-line whole tire was boosted ½¢.

Reclaimed rubber prices follow:

RECLAIMED RUBBER PRICES

Whole tire: first line	$0.11
Fourth line	.0975
Inner tube: black	.16
Red	.21
Butyl	.14
Pure gum, light colored	.23
Mechanical, light colored	.135

The above list includes those items or classes only that determine the price basis of all derivative reclaim grades. Every manufacturer produces a variety of special reclaims in each general group separately featuring characteristic properties of quality, workability, and gravity at special prices.

CYANAMID RUBBER Chem Lines

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FA SERIES

Published by AMERICAN CYANAMID COMPANY, Rubber Chemicals Department, Bound Brook, New Jersey

Guanidines as Accelerators and Activators

The guanidines (DPG and DOTG) have been available since 1920 for use as accelerators. Their use as a primary accelerator has been largely replaced by the thiazoles since the early 1930's. However, their use as secondary accelerators has accounted for their continued growth. As a result of their basicity, guanidines have a strong activating effect on the thiazoles. This accounts for their extensive use as secondary accelerators particularly in butadiene-styrene copolymers which cure at a slower rate than natural rubber. They still find use as primary accelerators, especially in highly loaded mechanical stocks. The relative characteristics of DPG and DOTG as both primary and secondary accelerators are best illustrated by the examples given below.

Using natural rubber and a loading of 90 to 100 parts of filler, normal amounts of oils, stearic acid, antioxidants and 2.5 parts sulfur, the following characteristics can be obtained:

	1.0 part DOTG	1.43 parts DPG
Mooney Scorch @ 240°F	11 min.	7 min.
Rex Hardness at Full Cure	64	64
Mod. @ 300% (Optimum Cure)	550 psi	550 psi
Tensile (Optimum Cure)	3000 psi	3025 psi

The use of DOTG gives a safer processing stock.

The results of oven aging and oxygen bomb aging indicate that the DPG accelerated stock exhibits somewhat better aging characteristics than the DOTG accelerated stock.

DPG and DOTG, used as activators for MBTS in this same high loaded base formula, gave the following results:

	0.6 part MBTS 0.2 part DOTG	0.6 part MBTS 0.3 part DPG
Mooney Scorch @ 250°F	24 min.	17 min.
Rex Hardness at Full Cure	65	64
Mod. @ 300% (Optimum Cure)	500 psi	525 psi
Tensile (Optimum Cure)	3050 psi	3125 psi

The aging characteristics of the activated thiazole accelerated stocks are considerably better than those for the straight guanidine accelerated stock. Again, the DPG activated stock has somewhat superior aging characteristics to the DOTG activated stock.

In a cold butadiene-styrene copolymer stock with 50 parts HAF black and 2 parts sulfur, DPG and DOTG were used as secondary accelerators with the following results:

	0.8 part MBTS 0.25 part DOTG	0.8 part MBTS 0.25 part DPG
Mooney Scorch @ 262°F	24	21
Mooney Scorch @ 280°F	12	11
Rex Hardness at Full Cure	71	70
Mod. @ 300% (Optimum Cure)	2050 psi	2150 psi
Tensile (Optimum Cure)	3550 psi	3475 psi

The scorch characteristics indicate that DOTG gives somewhat more processing safety than DPG when used as an activator for thiazoles. The modulus figures indicate a slight curing strength advantage for DPG.

* * *

More complete data on the above illustrations, and many others, is contained in the recently issued Cyanamid Technical Bulletin No. 848, *The Guanidine Accelerators*. If you are interested in these products, we, or the Cyanamid representative in your area, will be glad to supply a copy of this bulletin to you.

That Ounce of Prevention

Often a compounder is overloaded with laboratory work and cannot take the time to evaluate new or improved rubber chemicals if he has had no complaints about the type of materials presently in use. Here the old adage might apply, "An ounce of prevention is worth a pound of cure."

Cyanamid's new MBTS is an example of an improved product that is well worth the time necessary for a laboratory comparative evaluation. Generally speaking, what are the most important requirements for MBTS which will be most acceptable for use by a compounder?

The MBTS must be free of foreign contamination.

The purity of the MBTS must be consistently high.

The MBTS must disperse quickly and easily when compounded.

Variations cannot be tolerated since each might affect the processing and curing characteristics of the compound in which the MBTS is used.

American Cyanamid's new MBTS is outstanding in all of the above requirements. Our new equipment contains an improved reaction system and an electro-magnetic separator to insure the highest purity MBTS, free of foreign particle contamination. Revolutionary changes in milling and classifying equipment have narrowed our particle-size range and insure uniformity in all production runs. These changes make our standard production MBTS the best available, even for the most discriminating manufacturers.

It would be to the advantage of all compounders utilizing MBTS in their formulations to run a laboratory evaluation which will enable them to determine for themselves the advantage of Cyanamid's new MBTS.

With very little effort the compounder can make some simple sieve tests, comparative dispersion tests and the physical testing evaluation usually made on new materials.

The compounder's job will be made easier if Cyanamid's new MBTS is approved to insure quality products.

Scrap Rubber

Trading in the scrap rubber market during the January 16-February 15 period continued dull, according to industry observers. Higher temperatures during the last week of January permitted suppliers to work on filling mixed auto tire orders for early February shipment, but the thermometer fell again soon after, curtailing work.

Period-end prices of scrap rubber grades were as follows:

	Eastern Points	Akron, O.
	(Per Net Ton)	
Mixed auto tires	$10.00/13.50	$13.50/14.00
S.A.G. auto tires	Nom.	Nom.
Truck tires	Nom.	Nom.
Peelings, No. 1	40.00	40.00
2	Nom.	Nom.
3	16.00	17.00
Tire buffing	Nom.	Nom.
	(¢ per Lb.)	
Auto tubes, mixed	2.75	2.75
Black	6.25	5.75
Butyl	3.75	3.75
Red	6.75	6.75

Industrial Fabrics

Trading in wide industrial fabrics remained sluggish during the January 16-February 15 period, with buying in most fabrics confined to small, fill-in lots for spot and nearby delivery. One encouraging factor, however, was the report that stocks in the hands of plastic coaters were at relatively low levels, and it was expected that any stimulation in industrial activity will result in heavier trading of the fabrics.

Trading in cotton ducks during the period was generally more active than in wide industrial fabrics. Demand for enameling ducks, high during December of last year, has eased considerably.

Fractional reductions in the price of drills, most ducks, osnaburgs, raincoat fabrics, and sateens were in evidence over the period. Period-end prices follow:

INDUSTRIAL FABRICS

Drills		
59-inch 1.85 yd.	yd.	$0.36
2.25-yd.		.305
Ducks		
38-inch 1.78-yd. S.F.	yd.	nom.
2.00-yd. D.F.		.305
51.5-inch, 1.35-yd. S.F.		.489
Hose and belting		.69
Osnaburgs		
40-inch 2.11-yd.	yd.	.245
3.65-yd.		.16
Raincoat Fabrics		
Printcloth, 38½-in., 64-60, 5.35-yd.	yd.	.1375
6.25 yd.		.1188
Sheeting, 48-inch, 4.17-yd.		.20
52-inch, 3.85-yd.		.23
Chafer Fabrics		
14.40-oz./sq. yd. Pl.	yd.	.73
11.65-oz./sq. yd. S.		.61
10.80-oz/sq. yd. S.		.6575
8.9-oz/sq. yd. S.		.67
Other Fabrics		
Headlining, 59-in., 1.65-yd., 2-ply	yd.	.41
64-inch, 1.25-yd., 2-ply		.59
Sateens, 53-inch, 1.32-yd.		.5575
58-inch, 1.21-yd.		.61

Rayon

Rayon and acetate filament yarn domestic shipments during 1956 were 725,400,000 pounds, a 15% decrease from the 855,400,000 pounds shipped in 1955, according to the trade publication *Textile Organon*. Shipments in 1956 consisted of 357,500,000 pounds of high-tenacity rayon yarn and 367,900,000 pounds of regular-tenacity yarn.

Packaged filament yarn production during 1956 totaled 749,600,000 pounds, a 13% drop from the 865,100,000 pounds produced the year before. Production during 1956 consisted of 370,500,000 pounds of high-tenacity rayon yarn and 379,100,000 pounds of regular-tenacity yarn.

Total year-end stocks were reported at 62,200,000 pounds, 19% higher than the 52,000,000 pounds of stocks on hand at the end of December, 1955. These end-of-1956 stocks consisted of 13,200,000 pounds of high-tenacity rayon yarn, and 49,000,000 pounds of regular tenacity yarn.

Rayon and acetate filament yarn shipments for tires and related uses came to 345,100,000 pounds during 1956. During 1955, 416,200,000 pounds had been shipped. Prices of tire yarns and fabrics in mid-February were unchanged from the previous month's quotations.

RAYON PRICES

Tire Yarns	
High-Tenacity	
1100/ 480	$0.59/$0.64
1100/ 490	.59/ .64
1150/ 490	.64
1165/ 480	.65
1230/ 490	.64
1650/ 720	.55/ .61
1650/ 980	.55/ .61
1875/ 980	.61
2200/ 960	.55/ .60
2200/ 980	.55/ .60
2200/1466	.64
4400/2934	.60
Super-High-Tenacity	
1650/ 720	.58
1900/ 720	.58
Tire Fabrics	
1100/490/2	.77
1650/980/2	.725
2200/980/2	.715

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Financial

(*Continued from page 938*)

Rome Cable Corp., Rome, N. Y. Nine months ended December 31, 1956: net income, $1,716,000, equal to $3.08 a common share, against $1,370,000, or $2.86 a share, in the 1955 period.

Shell Oil Co., New York, N. Y., and wholly owned subsidiaries. For 1956: net earnings, $135,800,000, equal to $4.49 a capital share, against $125,532,000, or $4.14 a share, the year before.

Union Asbestos & Rubber Co., Chicago, Ill. For 1956: net profit, $14,668; equal to 3¢ each on 475,176 capital shares, contrasted with net loss of $270,813 in 1955; sales, $12,682,000, against $13,402,136.

Union Carbide & Carbon Corp., New York, N. Y. Year ended December 31, 1956: net profit $146,233,444, equal to $4.86 a share, compared with $145,834,416, or $4.86 a share, in the preceding year; sales, $1,349,420,526, against $1,251,901,729.

United States Rubber Co., New York, N. Y. For 1956: net income, $31,870,013, equal to $4.83 a common share, contrasted with $33,559,494, or $5.14 a share, in the previous year; net sales, $901,260,194, against $925,539,092; income taxes, $29,732,840, against $36,877,231; current assets, $423,856,880, current liabilities, $138,068,683, against $406,801,892 and $147,045,251, respectively, on December 31, 1955.

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Malaya

(*Continued from page 944*)

I would even go further and say that every encouragement will be given for the flow of foreign capital to Malaya, to help our economic development."

This was the assurance given to present and prospective investors in an independent Malaya, by the Chief Minister of the Malayan Federation, Tengku Abdul Rahman, in a speech made when he opened a new showroom of the Malaya House, in London.

Plantation Notes

The Federation Government banned the export of Tj.I seed until March 31, 1957, to insure that this seed, found most suitable for small holdings, would be in adequate supply for replanting on these holdings.

More schemes to train young Asians to become assistants or junior managers on estates have recently been initiated. Guthrie & Co., Ltd., started the project in November, 1954. R.E.A. and Cumberbatch, Ltd., will set up a centralized training school, the first of its kind, for potential assistant managers.

The next move by the Plantation Workers' Union will be to ask for a minimum wage system, the *Straits Times* learns, which will involve a minimum basic wage, plus a cost of living allowance and a prosperity bonus, varying with the price of rubber.

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Dunlop in Spain

Fabricacion Espanola de Neumaticos Dunlop is the name of a new company jointly formed by the Dunlop Rubber Company and the Sociedad Iberica de Gomas y Amiantas S.A., which will manufacture Dunlop tires in Spain. The company has received permission to build a factory at Bilbao, which is expected to start production about the middle of 1958. It is hoped eventually to be able to produce up to 600 units daily.

Are you measuring all the muscles in your base fabrics?

Fabric breaking strength is frequently given too much importance, when it is just one of at least seven kinds of strength that contribute to end-product performance!

Over-emphasis on one kind of strength can give a misleading picture of how a fabric-reinforced plastic or rubber product will behave. Depending on end use, the impact, shear, flex, tear, burst or stitch strength can be just as decisive as breaking strength. All together, they permit a much more dependable estimate of product capabilities.

When your base fabric is one of the many provided by Wellington Sears for coating, laminating, combining and rubberizing, you know that its strength *and all other properties* have been considered in the light of your specific need. And moreover you know that a century of experience is working for you, to anticipate and help solve your working-fabric problems.

New Booklet Now Ready! Write Dept. H-3, for "Fabrics Plus"

Wellington Sears

FIRST In Fabrics For Industry

For Mechanical Goods, Coated Materials, Tires, Footwear and Other Rubber Products

WEST POINT W2 TEXTILES

Wellington Sears Co., 65 Worth St., New York 13, N. Y. • Atlanta • Boston • Chicago • Dallas • Detroit • LosAngeles • Philadelphia • San Francisco • St. Louis

Synthetic Rubbers and Latices*

Acrylic Types

Hycar 4021	$1.35[c]
4501	.81[c]

Fluorocarbon Types

Kel-F Elastomer *lb.*	15.00 / 16.00

Isobutylene Types

Enjay Butyl 035, 150, 215, 217, 218, 325	.23[a]
165, 265, 267, 268, 365	.24[a]
Hycar 2202	.65[a]
Polysar Butyl 100, 200, 300, 400	.245[c]
101	.2775[a]
301	.255[c]
Vistanex	.45[a]

Neoprene

Neoprene Type AC, CG	.55[a]
GN, GN-A, WX	.41[a]
GRT, S	.42[a]
KNR	.75[a]
W, WHV	.39[a]
WRT	.45[a]

Latices

Neoprene Latex 571, 842-A	.37[a]
572	.39[a]
60, 601-A	.40[a]
635	.41[a]
735, 736	.38[a]
950	.47[a]

Nitrile Types

Butaprene NAA	.54[a]
NF	.49[a]
NL	.50[a]
NXM	.58[a]
Chemigum N1NS	.64[b]
N3NS, N5	.58[b]
N6, N-6B, N7	.50[b]
Hycar 1001, 1041	.58[a]
1002, 1042, 1043, 1312	.50[c]
1014	.60[c]
1411	.62[c]
1432	.59[c]
1441	.64[c]
Paracril AJ	.485[c]
B, BJ, BJLT, BLT	.50[c]
C, CLT	.58[c]
CV	.59[c]
D	.65[c]
18-80	.60[c]
Polysar Krynac 800, 802, 803	.50[c]
801	.58[c]

[a] Freight extra.
[b] Minimum freight allowed.
[c] Freight prepaid.
* Prices are per pound carload or tank-car dry weight unless otherwise specified.
†Listed below are the new SBR type synthetic rubbers and latices trade names and the chief sales offices of their producers or distributors.

Ameripol —Goodrich-Gulf Chemicals, Inc., 3135 Euclid Ave., Cleveland 15, O.
ASRC —American Synthetic Rubber Corp., 500 Fifth Ave., New York 36, N. Y.
Baytown —United Rubber & Chemical Co., Baytown, Tex. (producer); United Carbon Co., Inc., Charleston 27, W. Va. (distributor).
Butaprene, FR-S —Firestone Tire & Rubber Co., Synthetic Rubber Division, 381 Wilbeth Rd., Akron 1, O.
Copo —Copolymer Rubber & Chemical Corp., P. O. Box 2595, Baton Rouge 1, La.
Naugapol, Naugatex —Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.
Philprene —Phillips Chemical Co., Rubber Chemicals Division, 318 Water St., Akron 8, O.
Plioflex —Goodyear Tire & Rubber Co., Chemical Division, Akron 16, O.
Pliolite Latex—Goodyear Tire & Rubber Co., Chemical Division. Also distributed by General Latex & Chemical Corp., 666 Main St., Cambridge 39, Mass.
Polysar —Polymer Corp., Ltd., Sarnia, Ont., Canada (producer); H. Muehlstein & Co., Inc., 60 E. 42nd St., New York 17, N. Y. (distributor).
S- —Shell Chemical Corp., Synthetic Rubber Sales Division 50 W. 50th St., New York 20, N. Y.
Synpol —Texas-U. S. Chemical Co., Port Neches, Tex. (producer); Naugatuck Chemical (distributor).

‡SBR —Styrene butadiene rubber.
§BR —Butadiene rubber.

Latices

Butaprene N-300	$0.46[b]
N-400, N-401	.54[b]
Chemigum 200	.49[b]
235 CHS, 236	.54[b]
245 B, 245 CHS, 246, 247	.46[b]
Hycar 1512, 1552, 1562, 1577	.46[c]
1551, 1561, 1571	.54[c]
1852	.44[c]
Nitrex 2612, 2614	.46[a]
2615	.51[a]

Polyethylene Type

Hypalon 20 *lb.*	.85/.88

Polysulfide Types

Thiokol LP-2, -3, -32, -33	.96[a]
-8, -38	1.25[a]
PR-1	.95[a]
Type-A	.47[a]
FA	.69[a]
ST	1.00[a]

Latices

Thiokol Latex (dry wt.)	
Type MF	.85[a]
MX	.70[a]
WD-2	.92[a]
-5	.95[a]
-6, -7	.70[c]

Silicone Types

GE (compounded)	2.25[a]/4.10[a]
Silicone gum (not compounded)	3.85[a]/4.90[a]
Silastic (compounded)	1.95[b]/3.65[b]
(Partly compounded)	3.38[b]/3.90[b]
(Uncompounded)	3.85[b]/4.50[b]
Union Carbide (compounds)	2.35[b]/3.20[b]
(Gums)	3.85[b]/4.25[b]

Styrene Types†

Hot SBR‡

Ameripol 1000, 1001, 1006	.241[c]
1002	.2435[c]
ASRC 1000, 1001, 1004, 1006	.241[c]
1018	.276[c]
1019	.265[c]
FR-S 1000, 1001, 1004, 1006	.241[c]
1009	.2475[c]
1010	.26[c]
1012	.2425[c]
1013	.25[c]
1014	.281[c]
1015	.291[c]
Naugapol 1016, 1019	.265[b]
1018	.27[b]
1021	.30[b]
1022	.28[b]
1023	.285[b]
Philprene 1000, 1001, 1006	.241[b]
1009	.255[b]
1018	.27[b]
1019	.265[b]
Plioflex 1006	.241[c]
Polysar Kryflex 200, S, S-50	.241[c]
SS-250	.30[c]
S-X-371	.255[c]
S-1000, -1001, -1006, -1013	.23[a]
-1002, -1011	.2325[a]
Synpol 1000, 1001, 1006, 1007, 1061	.24[b]
1002	.2435[b]
1012	.2425[b]
1009	.2475[b]
1013	.25[b]

Hot SBR Black Masterbatch

S-1100	.185[a]

Cold SBR

Ameripol 1500, 1501, 1502	.241[c]
ASRC 1500, 1502	.241[c]
1503	.2625[c]
1505	.261[c]
1505	.261[c]
Copo 1500, 1502	.241[c]
1505	.261[c]
FR-S 1500, 1502	.241[c]
Naugapol 1503	.2625[b]
1504	.295[b]
Philprene 1500, 1502	$0.241[b]
1503	.2625[b]
Plioflex 1500, 1502	.241[c]
Polysar Krylene	.241[c]
S-1500, -1501, -1502	.23[b]
Synpol 1500, 1502, 1551	.241[b]

Cold SBR Black Masterbatch

Baytown 1600, 1601, 1602	.176[a]
Philprene 1601	.191[b]
1605	.188[b]
S-1600, -1601, -1602	.18[a]

Cold SBR Oil Masterbatch

Ameripol 1703	.206[c]
1705	.2035[c]
1707	.191[c]
1710, 1712	.1885[c]
ASRC 1703	.206[c]
1708	.191[c]
Copo 1712	.1885[c]
FR-S 1703	.206[c]
1705	.2035[c]
1712	.1885[c]
Philprene 1703	.206[b]
1706	.203[b]
1708	.191[b]
1712	.188[b]
Plioflex 1703, 1773	.206[c]
1710, 1712	.1885[c]
1778	.191[c]
Polysar Krynol 651	.1885[c]
652	.191[c]
S-1703	.195[a]
1705, 1706	.1925[a]
-1707	.18[a]
-1709, -1712	.1775[a]
Synpol 1703	.206[b]
1707, 1708	.191[b]
1711	.19[b]

Cold SBR Oil-Black Masterbatch

Baytown 1801	.16[a]
Philprene 1803	.173[b]
S-1801	.165[a]

Hot SBR Latices

FR-S 2000, 2001, 2006	.26[a]
2002	.285[a]
2003, 2004	.295[a]
Naugatex 2000, 2001, 2006	.263[a]
2002	.288[a]
2005	.30[a]
Pliolite Latex 2000, 2001	.2775[c]
2076	.29[c]
S-2000	.2275[a]
2006	.215[a]

Cold SBR Latices

FR-S 2105	.31[a]
Copo 2101, X-765	.30[c]
2102, 2105	.32[c]
Naugatex 2101	.285[a]
2105	.312[a]
X-767	.323[a]
Pliolite Latex 2101, X765	.30[c]
2104, 2105	.32[c]
S-2101	.225[a]

Cold BR Latex§

Pliolite Latex 2104	.32[c]

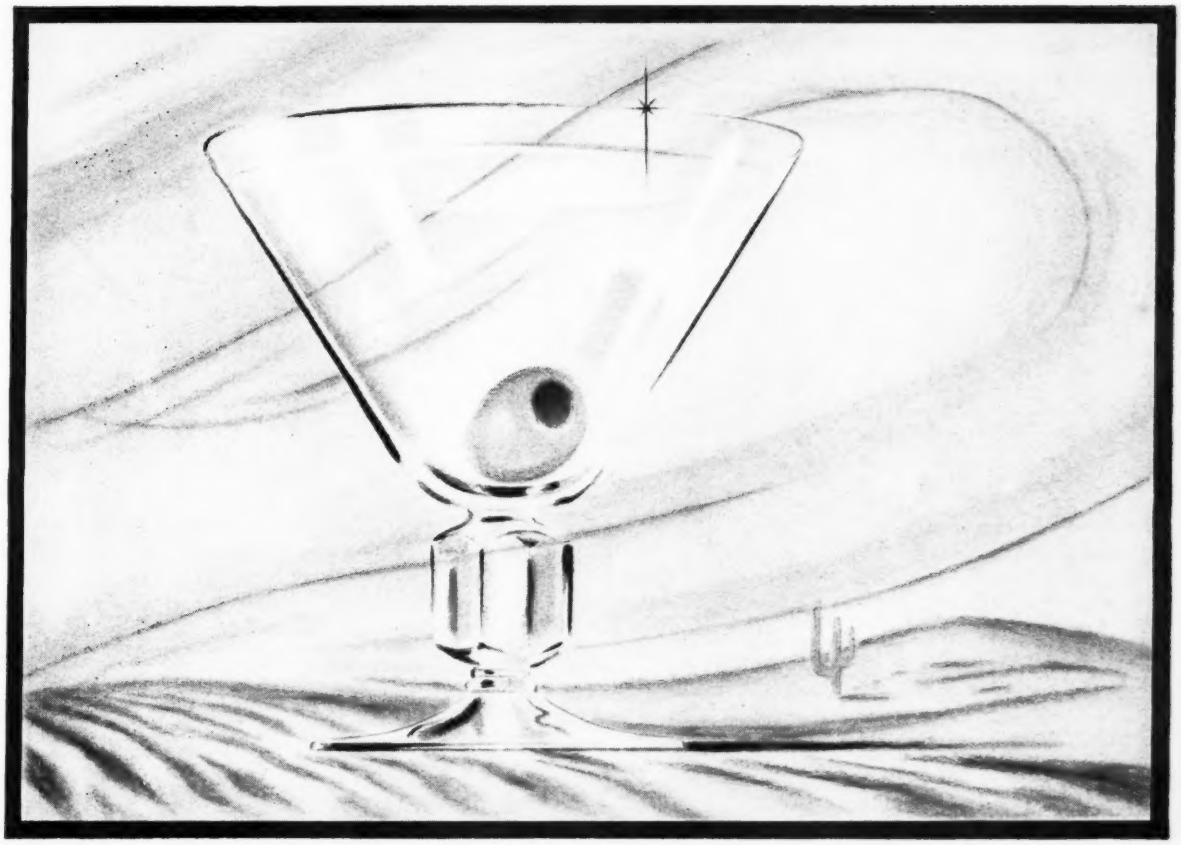
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Borden Formaldehyde Plant

A new formaldehyde plant with an annual production capacity of 36 million pounds has been opened by the chemical division of Borden Co. at Kent, Wash. The company has a similar operation at Springfield, Oreg., and says it is now the largest formaldehyde producer on the West Coast.

Borden sells formaldehyde commercially and also uses it in the manufacture of phenol, urea, and resorcinol resins, which are raw materials for the production of adhesives, coatings, and binders.

Naugatuck NAUGAPOLS



dry!

and they stay dry!

SPECIALLY PROCESSED for *low moisture absorption!* That's why Naugatuck Chemical's NAUGAPOLS® offer you 5 big advantages over ordinary grades of butadiene-styrene (R-S type) synthetic rubber. Special processing during transformation from the liquid copolymer state produces elastomers characterized by:

- **VERY LOW MOISTURE ABSORPTION**
- **EXTREME CLEANLINESS AND UNIFORMITY**
- **HIGH DIELECTRIC PROPERTIES**
- **LOW ASH CONTENT**
- **EASY SUBSEQUENT PROCESSING**

That's why NAUGAPOLS are so definitely preferred by manufacturers of rubber-insulated wire and cable...and by the makers of specialty mechanical rubber products. If *you* require special grades or special properties in synthetic rubber, let us help you solve your particular problem.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

IN CANADA: NAUGATUCK CHEMICALS DIVISION • Dominion Rubber Company, Limited, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

Compounding Ingredients*

Abrasives

Pumicestone, powdered	lb.	$0.0363/ $0.065
Rottenstone, domestic	lb.	.03 / .04
Shelblast	ton	80.00 / 165.00
Walnut Shell Grits	ton	50.00 / 160.00

Accelerators

A-1 (Thiocarbanilide)	ton	.50 / .57
A-32	ton	.66 / .80
A-100	lb.	.52 / .66
Accelerator 49	lb.	.57 / .58
52	lb.	1.14
57, 62, 67, 77	lb.	1.04
66	lb.	4.25
89	lb.	1.20
108	lb.	.91
552	lb.	2.25
808	lb.	.66 / .68
833	lb.	1.17 / 1.19
Altax	lb.	.50 / .52
Arazate	lb.	2.25
Beutene	lb.	.66 / .71
Bismate	lb.	3.00
B-J-F	lb.	.27 / .32
Butasan	lb.	1.04
Butazate	lb.	1.04
Butyl Accelerator Eight	lb.	1.10 / 1.35
Zimate	lb.	1.04
Captax	lb.	.40 / .42
C-P-B	lb.	1.95
Cumate	lb.	1.45
Dibs	lb.	.85
Diesterex N	lb.	.50 / .57
Dipac	lb.	.85
DOTG (diorthotolylguanidine)		
Cyanamid	lb.	.62 / .63
Du Pont	lb.	.62 / .63
DPG (diphenylguanidine)		
Cyanamid	lb.	.52 / .53
Monsanto	lb.	.52 / .58
El-Sixty	lb.	.60 / .67
Ethasan	lb.	1.04
Ethazate	lb.	1.04
50-D	lb.	.85
Ethyl Thiurad	lb.	1.04
Tuads	lb.	1.04
Tuex	lb.	1.04
Zimate	lb.	1.04
Ethylac #650	lb.	.93 / .95
Guantal	lb.	.60 / .67
Hepteen	lb.	.44 / .50
Base	lb.	1.85
Ledate	lb.	1.04
MBT (2-mercaptobenzothiazole)		
American Cyanamid	lb.	.42 / .44
Du Pont	lb.	.42 / .44
Naugatuck	lb.	.42 / .47
-XXX, Cyanamid	lb.	.53 / .55
MBTS (mercaptobenzothiazyl disulfide)		
Cyanamid	lb.	.52 / .54
Du Pont	lb.	.52 / .54
Naugatuck	lb.	.52 / .57
-W Cyanamid	lb.	.57 / .59
Merac #225	lb.	.75 / 1.05
Mertax	lb.	.53 / .60
Methasan	lb.	1.04
Methazate	lb.	1.04
Methyl Tuads	lb.	1.14
Zimate	lb.	1.04
Monex	lb.	1.14
Mono-Thiurad	lb.	1.14
2-MT (2-mercaptothiazoline)		
Du Pont	lb.	1.00
NOBS No. 1	lb.	.74 / .76
Special	lb.	.79 / .81
O-X-A-F	lb.	.53 / .58
Pentex	lb.	1.14
Flour	lb.	.26
Permalux	lb.	2.17
Phenex	lb.	.52 / .59
Pip-Pip	lb.	2.07
R-2 Crystals	lb.	4.35
Rotax	lb.	.51 / .53
RZ-50, -50B	lb.	1.00
S. A. 52	lb.	1.14
57, 62, 67, 77	lb.	1.04
66	lb.	2.50
Santocure	lb.	.74 / .81
NS	lb.	.79 / .86
Selenac	lb.	4.25
SPDX-GH	lb.	.69 / .74
GL	lb.	1.20 / 1.34
Tellurac	lb.	1.21
Tepidone	lb.	.45 / .48
Tetrone A	lb.	1.91
Thiofide	lb.	.52 / .59
S	lb.	.62 / .69
Thionex	lb.	1.14
Thiotax	lb.	.42 / .49
Thiurad	lb.	1.14
Thiuram E	lb.	1.04
M	lb.	1.14
Trimene	lb.	.56 / .62
Base	lb.	1.03 / 1.10
Tuex	lb.	$1.14
Ultex	lb.	1.00 / $1.10
Unads	lb.	1.14
Ureka Base	lb.	.66 / .73
Vulcacure NB	lb.	.45
ZB, ZE, ZM	lb.	.85
Z-B-X	lb.	2.45
Zenite	lb.	.52 / .54
A	lb.	.62 / .64
Special	lb.	.53 / .55
Zetax	lb.	.51 / .53
Zimate	lb.	1.04

Accelerator-Activators, Inorganic

Lime, hydrated	ton	21.96
Litharge, comml.	lb.	.175 / .18
Eagle, sublimed	lb.	.18
National Lead, sublimed	lb.	.18 / .19
Red lead, comml.	lb.	.185 / .195
Eagle	lb.	.19
National Lead	lb.	.19 / .20
White lead, carbonate	lb.	.19 / .20
Eagle	lb.	.19 / .20
National Lead	lb.	.18 / .19
Silicate	lb.	.1725/ .1825
Eagle	lb.	.20 / .2175
National Lead	lb.	.1625/ .1725
Zinc oxide, comml.†	lb.	.145/ .1925

Accelerator-Activators, Organic

Aktone	lb.	.2125/ .2325
Barak	lb.	.62
Capital 170	lb.	.215 / .255
171	lb.	.1375/ .1775
700, 701	lb.	.1575/ .1975
705,710	lb.	.1575/ .1975
800	lb.	.1125/ .1325
801	lb.	.1475/ .1675
802	lb.	.1525/ .1725
803	lb.	.175 / .195
Curade	lb.	.57 / .59
D-B-A	lb.	1.95
Emery 600	lb.	.1375/ .1775
Groco 30	lb.	.1375/ .1775
35	lb.	.1425/ .1825
Guantal	lb.	.57 / .64
Hyfac 400	lb.	.1063/ .1325
430	lb.	.1613/ .1875
431	lb.	.1837/ .21
Hystrene S-97	lb.	.1863/ .2125
T-45	lb.	.1638/ .19
T-70	lb.	.1738/ .20
Industrene B	lb.	.1263/ .1525
R	lb.	.1138/ .14
158	lb.	.1313/ .1575
254	lb.	.1413/ .1675
262	lb.	.1513/ .1775
Laurex	lb.	.33 / .37
MODX	lb.	.295 / .345
NA-22	lb.	1.00
Oleic acid, comml.	lb.	.185 / .225
Emersol 210 Elaine	lb.	.1575/ .1975
Groco 2, 4, 8, 18	lb.	.1575/ .1975
Plastone	lb.	.27 / .30
Polyac	lb.	1.85
Ridacto	lb.	.25 / .26
Seedine	lb.	.1485/ .1703
Stearex Beads	lb.	.1488/ .1588
Stearic acid		
Emersol 120	lb.	.1463/ .1725
150	lb.	.1787/ .205
Hydrofoil 51	lb.	.09
Hydrogenated, rubber grd.		
Groco	lb.	.125 / 145
Rufat 75	lb.	1188/ .145
Single pressed, comml.	lb.	.1475/ .1675
Emersol 110	lb.	.1413/ .1675
Groco 53	lb.	.1475/ .1675
Wilmar 253	lb.	.1413/ .1675
Double pressed, comml.	lb.	.1525/ .1725
Groco 54	lb.	.1525/ .1725
Wilmar 254	lb.	.1463/ .1725
Triple pressed, comml.	lb.	.175 / .195
Groco 55	lb.	.175 / .195
Wilmar 255	lb.	.1688/ .195
Sterene 60-R	lb.	.09 / .1075
Tonox	lb.	.515 / .605
Vulklor	lb.	.88 / 1.08
Wilmar 110	lb.	.165 / .205
434	lb.	.1375/ .1775
Zinc stearate comml.	lb.	.39 / .44

Antioxidants

AgeRite Alba	lb.	2.35 / 2.45
Gel	lb.	.64 / .66
H. P.	lb.	.72 / .74
Hipar	lb.	.98 / 1.00
Powder	lb.	.52 / .54
Resin	lb.	.75 / .77
D	lb.	.52 / .54
Spar	lb.	.52 / .54
Stalite	lb.	.52 / .54
S	lb.	.52 / .54
White	lb.	1.45 / 1.55
Akroflex C	lb.	.81 / .83
CD	lb.	.76 / .78
Albasan	lb.	.69 / .73
Allied AA-1144	lb.	.23 / .24
AA-1177	lb.	.155 / .165
Aminox	lb.	.55 / .60
Antioxidant 425	lb.	2.47 / 2.50
2246	lb.	1.50 / 1.53
Antisol	lb.	$0.23 / $0.24
Antisun	lb.	.15 / .51
Antox	lb.	.55 / .57
Aranox	lb.	3.25 / .54
Betanox Special	lb.	.85 / .90
B-L-E, -25	lb.	.55 / .60
Burgess Antisun Wax	lb.	.185
B-X-A	lb.	.55 / .60
Copper Inhibiter X-872-L	lb.	2.01
D-B-P-C	lb.	.91 / 1.16
Flectol H	lb.	.55 / .62
Flexamine	lb.	.76 / .81
Heliozone	lb.	.31 / .32
Ionol	lb.	.91 / 1.65
Microflake	lb.	.20 / .24
NBC	lb.	1.55
Neozone A	lb.	.59 / .61
C	lb.	.83
D	lb.	.55 / .57
Nevastain A	lb.	.51 / .61
B	lb.	.51 / .70
Octamine	lb.	.55 / .60
PDA-10	lb.	.46 / .48
Perflectol	lb.	.61 / .68
Permalux	lb.	2.17 / .
Polygard	lb.	.55 / .60
Polylite	lb.	.55 / .60
Protector	lb.	.26 / .31
Rio Resin	lb.	.60 / .62
Santoflex 35	lb.	.72 / .79
75	lb.	.97 / 1.04
AW	lb.	.78 / .85
B	lb.	.52 / .59
BX	lb.	.63 / .70
DD	lb.	.55 / .62
Santovar A	lb.	1.50 / 1.57
Santowhite Crystals, Powder	lb.	1.55 / 1.62
L	lb.	.55 / .62
MK	lb.	1.25 / 1.32
Sharples Wax	lb.	.23 / .28
Stabilite	lb.	.55 / .59
Alba	lb.	.72 / .79
L	lb.	.60 / .64
White	lb.	.52 / .60
Powder	lb.	.41 / .47
Styphen I	lb.	.51 / .55
Sunolite #100	lb.	.21 / .23
#127	lb.	.17 / .19
Sunproof -713	lb.	.25 / 30
Improved	lb.	.25 / .30
Jr.	lb.	.20 / .25
Tenamene 3	lb.	.91 / 1.05
Thermoflex A	lb.	1.00 / 1.02
Tonox	lb.	.52 / .57
Tysonite	lb.	.24 / .2475
Velvapex 51-250	lb.	.40 /
V-G-B	lb.	.75 / .80
Wing-Stay S	lb.	.53 / .65
Zenite	lb.	.52 / .54

Antiozonants

Tenamene 30, 31	lb.	1.36 / 1.38
UOP 88, 288	lb.	1.25 / 1.29

Antiseptics

Copper naphthenate, 6-8%	lb.	.245
Pentachlorophenol	lb.	.22 / .30
Resorcinol, technical	lb.	.775 / .785
Zinc naphthenate, 8-10%	lb.	.245 / .30

Blowing Agents

Ammonium bicarbonate	lb.	.07 / .09
Carbonate	lb.	.16
Blowing Agent CP 1475	lb.	.32 / .35
Celogen	lb.	1.95
50-C	lb.	1.01 / 1.07
Sodium bicarbonate	100 lbs.	2.55 / 3.85
Carbonate, tech.	100 lbs.	1.35 / 5.52
Sponge Paste	lb.	.20
Unicel ND	lb.	.76
NDX	lb.	1.52
S	lb.	.20

Bonding Agents

Braze	gal.	6.00 / 9.00
Cover cement	gal.	2.50 / 4.00
Chem-Lok 201	gal.	5.90 / 6.50
Flocking Adhesive RFA17, RFA22, RFA25	lb.	.50
G-E Silicone Paste SS-15	lb.	4.52 / 5.10
SS-64	lb.	3.65 / 6.75
-67 Primer	lb.	7.50 / 12.50
Gen-Tac Latex	lb.	.70 / .805
Hylene M	gal.	3.50 / 3.75
M-50	gal	1.90 / 2.15
Kalabond Adhesive	gal.	6.50 / 16.00
Tie Cement	gal.	2.00 / 5.60
Thixons	gal.	1.48 / 12.00
Ty Ply BN, Q, S, UP, 3640	gal.	6.75 / 8.00
RC	gal.	3.75 / 5.00

Brake Lining Saturants

BRT 3	lb.	.018 / .0265
Resinex L-S	lb.	.0225/ .03

Carbon Blacks‡

Conductive Channel—CC

Continental R-40	lb.	.23 / .30
Kosmos/Dixie BB	lb.	.23 / .30
Spheron C	lb.	.15 / .195
Voltex	lb.	.18 / .315

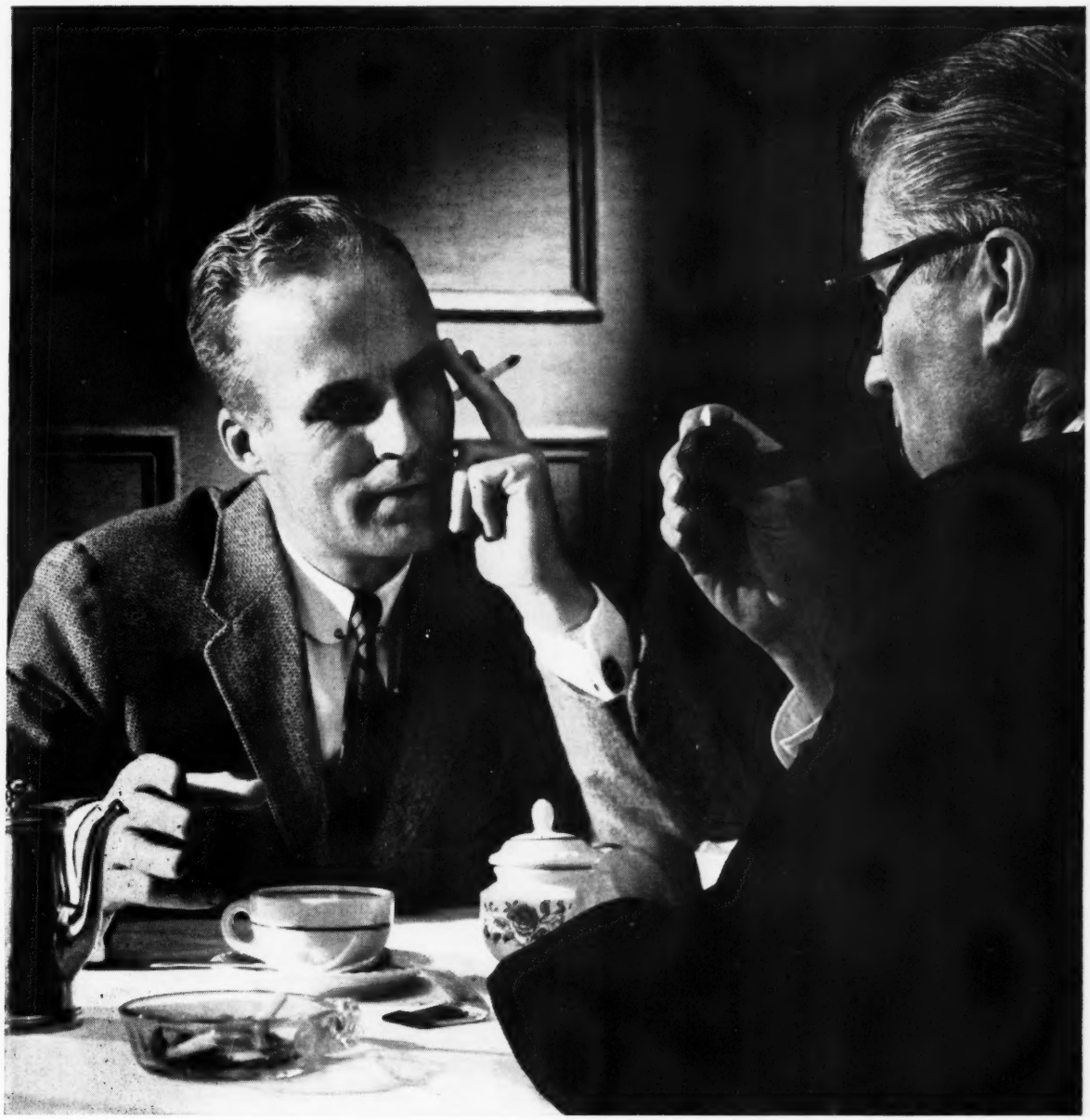
Easy Processing Channel—EPC

Collocarb EPC	lb.	.059 / .099
Continental AA	lb.	.074 / .1225

* Prices, in general, are f.o.b. works. Range indicates grade or quantity variations. No guarantee of these prices is made. Spot prices should be obtained from individual suppliers.

† For trade names, see Color—White, Zinc Oxides.

‡ At the request of the suppliers, the lowest prices shown for carbon blacks are for carloads in bags. Prices for hopper carloads are lower.



Does debate settle a hot problem?

(Dow salesmen let Vulcosal speak for itself)

Some problems can be solved by airing the pros and cons. But in the final analysis, don't we all say, "Let's see the proof"?

Is Vulcosal* truly a dustless industrial salicylic acid? Does this retarder solve scorching problems best?

Numerous manufacturers of rubber products have found the answers to be definitely "yes" and are benefiting accordingly. They made firsthand examinations of Vulcosal; for neither description nor debate can resolve a problem that involves a switch in process . . . that puts money at stake. Results rule.

So our salesmen let Vulcosal speak for itself—not as a last resort, but as a spearhead. For testing Vulcosal results in buying Vulcosal! Test a sample yourself!

See how it ends scorching problems and, at the same time, improves working conditions through its lack of dust. THE DOW CHEMICAL COMPANY, Midland, Mich.. Dept. FC859M.

*Trademark of The Dow Chemical Company

YOU CAN DEPEND ON DOW

Kosmobile 77/Dixiedensed			
77	lb.	$0.074 /	$0.1225
Micronex W-6	lb.	.0725/	.14
Spheron #9	lb.	.0725/	.1225
Texas E	lb.	.074 /	.1225
Witco #12	lb.	.074 /	.1225
Wyex EPC	lb.	.0725/	.13
Hard Processing Channel—HPC			
Continental F	lb.	.074 /	.1225
HX HPC	lb.	.074 /	.1225
Kosmobile S/Dixiedensed			
S	lb.	.074 /	.1225
Micronex Mk. II	lb.	.0725/	.14
Witco #6	lb.	.074 /	.1225
Medium Processing Channel—MPC			
Arrow MPC	lb.	.0725/	.13
Continental A	lb.	.074 /	.1225
Kosmobile S-66/Dixiedensed			
S-66	lb.	.074 /	.1225
Micronex Standard	lb.	.0725/	.14
Spheron #6	lb.	.0725/	.1225
Texas 109	lb.	.079 /	.1275
M	lb.	.074 /	.1225
Witco #1	lb.	.074 /	.1225
Conductive Furnace—CF			
Aromex CF	lb.	.0825/	.14
Vulcan C	lb.	.105 /	.15
SC	lb.	.18 /	.223
Fast Extruding Furnace—FEF			
Arovel FEF	lb.	.0625/	.12
Continex FEF	lb.	.06 /	.10
Kosmos 50/Dixie 50	lb.	.06 /	.10
Statex M	lb.	.0625/	.12
Sterling SO	lb.	.0625/	.10
Fine Furnace—FF			
Statex B	lb.	.0675/	.125
Sterling 99	lb.	.0675/	.105
High Abrasion Furnace—HAF			
Aromex HAF	lb.	.0725/	.13
Continex HAF	lb.	.079 /	.125
Kosmos 60/Dixie 60	lb.	.079 /	.1175
Philblack O	lb.	.0725/	.12
Statex R	lb.	.0725/	.13
Vulcan #3	lb.	.0725/	.114
Intermediate Super Abrasion Furnace—ISAF			
Aromex ISAF	lb.	.0875/	.145
Kosmos 70/Dixie 70	lb.	.10 /	.145
Philblack I	lb.	.0875/	.135
Statex 125	lb.	.0875/	.145
Vulcan 6	lb.	.0875/	.13
Medium Abrasion Furnace—MAF			
Philblack A	lb.	.0625/	.11
Super Abrasion Furnace—SAF			
Philblack E	lb.	.115 /	.1625
Vulcan 9	lb.	.115 /	.165
General Purpose Furnace—GPF			
Arogen GPF	lb.	.055 /	.1125
Sterling V	lb.	.055 /	.09
V Non-staining	lb.	.05 /	.09
High Modulus Furnace—HMF			
Collocarb HMF	lb.	.045 /	.085
Continex HMF	lb.	.055 /	.095
Kosmos 40/Dixie 40	lb.	.055 /	.095
Modulex HMF	lb.	.0575/	.115
Statex 93	lb.	.0575/	.115
930	lb.	.047 /	.087
Sterling L, LL	lb.	.0575/	.095
Semi-Reinforcing Furnace—SRF			
Collocarb SRF	lb.	.042 /	.082
Continex SRF	lb.	.045 /	.085
Essex SRF	lb.	.0525/	.11
Furnex	lb.	.0525/	.11
Gastex	lb.	.0575/	.0925
Kosmos 20/Dixie 20	lb.	.045 /	.085
Pelletex, NS	lb.	.0525/	.0875
Sterling NS, S	lb.	.0475/	.0875
R	lb.	.0575/	.0925
Fine Thermal—FT			
P-33	lb.	.0575	
Sterling FT	lb.	.0575	
Medium Thermal—MT			
Sterling MT	lb.	.04	
Non-staining	lb.	.05	
Thermax	lb.	.04	
Stainless	lb.	.05	

Colors

Black

Iron oxides, comml	lb.	.1325/	.135
BK—Lansco	lb.	.1275/	.13
Williams	lb.	.145	
Lansco synthetic	lb.	.10	
Mapico	lb.	.1425/	.145
Lampblack, comml	lb.	.16 /	.45
Superjet	lb.	.085 /	.12
Permanent Blue	lb.	.80 /	1.05
Stan-Tone	lb.	.45 /	1.20
Vansul masterbatch	lb.	.60 /	.65
Paste	lb.	.14 /	.15

Blue

Alkali Blue	lb.	$1.12 /	$2.10
Cyanamid ultramarine	lb.	.29	
Du Pont	lb.	1.77 /	4.55
Filo	lb.	.28	
Heveatex pastes	lb.	.80 /	1.45
Lansco ultramarines	lb.	.25 /	.28
Monsanto Blue 7	lb.	1.55	
11	lb.	3.45	
DPB-283	lb.	1.93	
S-11	lb.	2.05	
Permanent Blue	lb.	.80 /	1.05
Stan-Tone	lb.	1.55 /	1.60
Vansul masterbatch	lb.	.90 /	2.70

Brown

Filo	lb.	.13	
Iron oxides, comml	lb.	.1425/	.145
Lansco synthetic	lb.	.125	
Mapico Brown	lb.	.1525/	.155
Sienna, burnt, comml	lb.	.0425/	.155
Williams	lb.	.115 /	.1775
Raw, comml	lb.	.045 /	.1325
Williams	lb.	.08 /	.1725
Umber, burnt, comml	lb.	.06 /	.07
Williams	lb.	.0725/	.085
Raw, comml	lb.	.0625/	.07
Williams	lb.	.07 /	.0825
Williams pure brown	lb.	.155	
Vandyke	lb.	.12	
Mapico Tan 15, 20	lb.	.2275/	.23
Metallic Brown	lb.	.05 /	.06
Vansul masterbatch	lb.	2.10 /	2.20

Green

Chrome	lb.	.19 /	.50
Green	lb.	.80 /	2.40
Oxide	lb.	.3925/	1.10
Cyanamid	lb.	1.10	
G-4099, -6099	lb.	.4525	
GH-9869	lb.	1.10 /	1.25
9976	lb.	1.20 /	1.35
Du Pont	lb.	1.97 /	2.80
Filo	lb.	.40	
Heveatex pastes	lb.	.95 /	1.85
Lansco Toner	lb.	1.35	
Monsanto Green 3	lb.	2.75	
14	lb.	1.45	
17	lb.	3.95	
71205	lb.	1.35	
DGP	lb.	2.03	
S-17	lb.	2.25	
Stan-Tone	lb.	1.75 /	4.60
Vansul masterbatch	lb.	2.00 /	2.60

Orange

Cyanamid Permatons	lb.	1.35	
Du Pont	lb.	2.75	
Monsanto Orange 68187	lb.	2.90	
Stan-Tone	lb.	.70 /	5.05
Vansul masterbatch	lb.	2.00 /	2.60

Red

Antimony trisulfide	lb.	.285 /	.315
R. M. P. No. 3	lb.	.72	
Sulfur Free	lb.	.78	
Brilliant Toning Red	lb.	1.95	
Cadmium red lithopones	lb.	2.21 /	3.77
Cadmolith	lb.	1.72 /	2.20
Cyanamid	lb.	.80 /	1.60
Du Pont	lb.	1.47 /	1.90
Filo	lb.	.11	
Indian Red	lb.	.1275	
Iron oxide, comml	lb.	.06 /	.13
Lansco synthetic	lb.	.1175	
Mapico	lb.	.1375/	.14
Recco	lb.	.12	
Williams Red	lb.	.13 /	.1525
Monsanto Maroon 113	lb.	1.50	
61148	lb.	1.75	
Red 7	lb.	1.55	
41	lb.	4.40	
3501	lb.	1.15	
4004	lb.	1.50	
69191	lb.	3.38	
Autumn	lb.	1.10	
PRP-285	lb.	1.27	
S-44	lb.	1.28	
Rub-Er-Red	lb.	.0975	
Stan-Tone	lb.	.85 /	6.15
Vansul masterbatch	lb.	.95 /	3.30
Venetian	lb.	.04 /	.0675

White

Antimony oxide	lb.	.27 /	.285
Burgess Iceberg	ton	50.00 /	80.00
Cryptone RT	lb.	.10 /	.11
Permolith lithopone	lb.	.08 /	.0875
Titanium pigments			
Horse Head Anatase	lb.	.255 /	.27
Rutile	lb.	.275 /	.29
Rayox LW	lb.	.195 /	.205
R 110	lb.	.215 /	.225
Ti-Cal	lb.	.075 /	.0825
Ti-Pure	lb.	.195 /	.225
Titanox A, AA, A-168	lb.	.21 /	.22
C-50	lb.	.1225/	.1275
RA, -10, -50	lb.	.23 /	.24
RC	lb.	.0825/	.0875
-HT, -HTX	lb.	.08 /	.085
Unitane	lb.	.255 /	.285
Zopaque Anatase	lb.	.245 /	.27
Rutile	lb.	.205 /	.29
Zinc oxide, comml	lb.	.145 /	.1825
Azo ZZZ-11, -44, -55	lb.	.145 /	.165
20% leaded	lb.	.1505/	.1705
35% leaded	lb.	.155 /	.175
50% leaded	lb.	.1588/	.1788
Eagle AAA, lead free	lb.	$0.145 /	$0.155
5% leaded	lb.	.145 /	.155
35% leaded	lb.	.155 /	.165
50% leaded	lb.	.159 /	.169
Florence Green Seal	lb.	.1625/	.1725
Red Seal	lb.	.1575/	.1675
White Seal	lb.	.1675/	.1775
Horsehead XX-4, -78	lb.	.145 /	.155
Kadox-15, -17, -72, -515	lb.	.145 /	.155
-25	lb.	.1675/	.1775
Lehigh, 35% leaded	lb.	.155 /	.175
50% leaded	lb.	.1588/	.1788
Protox-166, -167	lb.	.145 /	.165
St. Joe, lead free	lb.	.122 /	.152
Zinc sulfide, comml	lb.	.253 /	.263
Cryptone ZS	lb.	.253 /	.273

Yellow

Cadmium yellow lithopones	lb.	1.12 /	1.15
Cadmolith	lb.	1.12 /	1.20
Cyanamid Hansa Yellow	lb.	2.10	
Du Pont	lb.	1.80 /	2.25
Filo	lb.	.10	
Iron oxide, comml	lb.	.0525/	.1175
Lansco synthetic	lb.	.1075	
Mapico	lb.	.115 /	.1225
Williams	lb.	.115 /	.1225
Monsanto Yellow 14	lb.	1.91	
10010	lb.	1.91	
BYP-282	lb.	1.21	
GA	lb.	2.45	
S-10010	lb.	1.17	
Stan-Tone	lb.	1.00 /	1.55
Vansul masterbatch	lb.	.95 /	1.95
Williams Ocher	lb.	.0575/	.06

Dusting Agents

Diatomaceous silica	ton	32.00 /	48.00
Extrud-o-Lube, conc	gal.	1.33 /	1.69
Glycerized Liquid Lubricant, concentrated	gal.	1.25 /	1.63
Latex-Lube GR	lb.	.20	
Pigmented	lb.	.1825	
R-66	lb.	.165	
Liqui-Lube	lb.	.1625	
N. T.	lb.	.1675	
Liquizinc No. 305	lb.	.30 /	.35
Lubrex	lb.	.25 /	.30
Mica Concord	lb.	.075 /	.0825
Mineralite	ton	45 00	
Pyrax A	ton	13 50	
W. A.	ton	16.00	
Talc, comml	ton	18.40 /	38.50
EM	ton	11.00 /	63.00
LS Silver	ton	29 25	
Nytals	ton	25 00 /	36.00
Sierra Sagger 7	ton	34 00	
White IR	ton	19.75	
III	ton	20.75	
Vanfre	gal.	2.00 /	

Extenders

BRS 700	lb.	.02 /	.0285
BRT 7	lb.	.03 /	.031
Cumar Resins	lb.	.065 /	.17
Dielex B	lb.	.06	
Factice, Amberex	lb.	.29 /	.36
Brown	lb.	.1425/	.263
Neophax	lb.	.157 /	.268
White	lb.	.144 /	.285
G. B. Asphaltenes	lb.	.06 /	.065
Millex, W	lb.	.07	
Mineral Rubbers			
Black Diamond	ton	38.00 /	40.00
Hard Hydrocarbon	ton	46 50 /	48.50
Hydrocarbon MR	ton	45.00 /	55.00
Parmr	ton	21.00 /	29.00
T-MR Granulated	ton	47.50 /	50.00
Nuba No. 1, 2	lb.	.0574/	.0625
3X	lb.	.0775/	.0825
OPD-101	lb.	.26	
Rubber substitute, brown	lb.	.16 /	.2572
Car-Bel-Ex A	lb.	.14	
Car-Bel-Lite	lb.	.35	
Extender 600	lb.	.1765	
White	lb.	.192 /	.2103
Stan-Shells	ton	35.00 /	73.00
Sublac Resin PX-5	lb.	.215 /	.235
Sundex 53	gal.	.12	
85	gal.	.1725	
Synthetic 100	lb.	.41	
Vistanex	lb.	.35 /	475

Fillers, Inert

Agrashell flour	ton	50.00 /	74.00
Barytes, floated, white	ton	49.00 /	70.85
Off-color, domestic	ton	25 00	
No. 1	ton	49.00 /	71.50
2	ton	47.00 /	69.50
Sparmite	ton	90 00 /	110.00
Blanc fixe	ton	100.00 /	165.00
Burgess Iceberg	ton	50.00 /	80.00
Pigment #20	ton	35.00 /	60.00
#30	ton	37.00 /	60.00
HC-75	ton	12.00 /	30.00
-80	ton	14.00 /	32.00
WP #1	ton	11.00 /	16.00
Cary #200	ton	30 00 /	55.00
Citrus seed meal	lb.	.04	
Oil	lb.	.15	
Clays			
A. F. D. Filler	ton	26.50 /	100.00
Aiken	ton	14.00	
Albacar	ton	50.00 /	55.00
Aluminum Flake	ton	22.25 /	60.00
#5	ton	24.50 /	30.00
Champion	ton	14.00	
Crown	ton	14.00 /	33.00
Dixie	ton	14.00	
Franklin	ton	13.50 /	35.25

CLASSIFIED ADVERTISEMENTS

ALL CLASSIFIED ADVERTISING MUST BE PAID IN ADVANCE

GENERAL RATES	SITUATIONS WANTED RATES	SITUATIONS OPEN RATES
Light face type $1.25 per line (ten words) Bold face type $1.60 per line (eight words) *Allow nine words for keyed address.*	Light face type 40c per line (ten words) Bold face type 55c per line (eight words)	Light face type $1.00 per line (ten words) Bold face type $1.40 per line (eight words) *Letter replies forwarded without charge, but no packages or samples.*

Address All Replies to New York Office at 386 Fourth Avenue, New York 16, N. Y.

SITUATIONS WANTED

PRESENTLY EMPLOYED EXECUTIVE, EXPERIENCED IN all technical and manufacturing phases of rubber and plastics, wants new position as Plant Manager. Accustomed to management and compounding problems. Conscientious and energetic. Address Box No. 2045, care of RUBBER WORLD.

FACTORY MANAGER, ENGINEER, 15 YEARS' EXPERIENCE in molded, extruded, and latex products. Possesses initiative and can handle personnel. Able to compound all types of elastomers. Knows rubber machinery, new processes, and cost reduction. All phases of management including personnel administration, statistical quality control, and sales organization. Languages. Experience in Europe and Latin America. Free to Travel. Address Box No. 2049, care of RUBBER WORLD.

SITUATIONS OPEN

INDUSTRIAL SALESMEN

to work for progressive, fast-growing company in the synthetic rubber field. Sales locations to be Midwest and eastern districts. Experience desirable, but not essential. If interested, write for interview to Box No. 2046, care of RUBBER WORLD, submitting brief resumé of your training and experience.

RUBBER CHEMIST WANTED WITH EXPERIENCE IN COMpounding, processing, and development work. Small plant. Profit sharing. Opportunity to be one of management team in going concern. Address Box No. 2047, care of RUBBER WORLD.

SITUATIONS OPEN (Continued)

CHEMIST

Wanted by mfr of MOLDED MECHANICAL & CUT RUBBER ITEMS

Should be familiar with various polymers and should have experience in Production and Specification compound development.

Medium size independent organization. New England location. Good opportunity for right man.

ADDRESS BOX NO. 2044, c/o RUBBER WORLD

ESSO RESEARCH

BUTYL RUBBER TIRES

Leading scientific organization offers unusual opportunities for graduate chemists and chemical engineers in rapidly expanding development and technical service program on butyl rubber tires. Experience in tire compounding, fabrication, design, or evaluation desirable. Assignments include laboratory and field studies coupled with technical contacts with the rubber industry.

Give full details of education, experience, desired salary, availability date and references. All inquiries will be considered promptly and held confidential.

ESSO RESEARCH AND ENGINEERING COMPANY

Chief Technical Subsidiary—Standard Oil Company (New Jersey)

Esso Research Center
Employee Relations-C

P.O. Box 51 **Linden, N.J.**

Clays (*cont'd*)			
GK Soft Clay	ton	$11.00	
Hi-White R	ton	13.50	
Hydratex R	ton	28.00	
Kaolloid	ton	10.50	
Paragon	ton	13.50	/ $31.50
McNamee	ton	13.50	
RX-43	ton	33.00	
Recco	ton	14.00	
Sno-Brite	ton	12.50	
Stan-Clay	ton	28.00	
Stellar-R	ton	50.00	
Suprex	ton	14.00	/ 32.00
Swanee	ton	12.50	
Windsor	ton	14.00	/ 30.00
DC Silica	lb.	1.45	/ 1.65
Diatomaceous silica	ton	32.00	/ 48.00
Flocks			
Cotton, dark	lb.	.095	/ .135
Dyed	lb.	.55	/ .60
White	lb.	.13	/ .33
Fabrifil X-24-G	lb.	.135	
X-24-W	lb.	.235	
Filfloc 6000	lb.	.33	
F-40-900	lb.	.135	
HSC #35 Silicone Emulsion	lb.	1.22	/ 2.46
Kalite	ton	50.00	/ 65.00
Lithopone, commil	lb.	.075	/ .085
Astrolith	lb.	.06⅜	/ .0675
Eagle	lb.	.0725	/ .075
Permolith	lb.	.08	/ .0875
Sunolith	lb.	.075	/ .0825
Mica Concord	lb.	.075	/ .0825
Millical	ton	38.00	/ 53.00
Mineralite	ton	40.00	/ 60.00
Non-Fer-Al	ton	32.50	/ 47.50
Purecal	ton	56.75	/ 71.75
Pyrax A	ton	13.50	
W. A.	ton	16.00	
Sawdust	ton	14.00	/ 35.00
Silversheen Mica	lb.	.08	/ .09
StanWhite	ton	10.50	/ 13.10
Super-White Silica	ton	25.00	/ 46.50
Surfex	ton	37.50	/ 52.50
MM	ton	39.50	/ 54.50
Suspenso	ton	35.50	/ 50.50
Ti-Cal	lb.	.0675	
Valron estersil	lb.	2.00	/ 2.25
Walnut shell flours	ton	50.00	/ 84.00
Whiting, limestone			
Atomite	ton	30.00	
Calcite	ton	23.00	
Calwhite	ton	20.00	
-T	ton	23.00	
Gamaco	ton	32.50	
Keystone	ton	16.00	
Laminar	ton	30.00	
No. 10 White	ton	11.00	
Omya	ton	30.00	
Paxinosa	ton	11.00	/ 19.00
Snowflake	ton	17.00	/ 18.00
Stonelite	ton	9.00	
Witco	ton	8.50	
York	ton	9.50	

Finishes

Apex Bright Finish #5200-E	lb.	.25	
Rubber Finish	gal.	2.50	
Black-out	gal.	4.50	/ 8.00
Flocks, Rayon, colored	lb.	.90	/ 1.50
White	lb.	.75	/ 1.25
Also see Flocks, under Fillers, Inert			
Rubber lacquer, clear	gal.	1.00	/ 2.00
Shellacs, Angelo	lb.	.485	/ .7325
Vac Dry	lb.	.485	/ .57
Talc (*See Talc, under Dusting Agents*)			
Unidip	lb.	.15	/ .20
Wax, Bees	lb.	.68	/ .83
Carnauba	lb.	.57	/ 1.13
Monten	lb.	.27	
No. 118, colors	gal.	.86	/ 1.41
Neutral	gal.	.76	/ 1.31
Van Wax	gal.	1.45	/ 1.50

Latex Compounding Ingredients

Acintol D, DLR	lb.	.06	/ .075
FA #1	lb.	.065	/ .08
#2	lb.	.075	/ .09
Accelerator 552	lb.	2.25	
J-117, -302	lb.	1.00	/ 1.15
-144	lb.	.15	/ .30
-307	lb.	1.10	/ 1.25
-311	lb.	.60	/ .75
Aerosol, dry types	lb.	.39	/ 1.20
Liquid types	lb.	.40	/ .72
Alcogum AN-6	lb.	.05	
AN-10	lb.	.085	
Alrosol	lb.	.41	
Alrowet D-75	lb.	.63	
Amberex solutions	lb.	.1675	/ .18
Antifoam J-114	lb.	3.25	/ 3.45
P-242	lb.	.24	/ .35
Antioxidant J-137, -140	lb.	.55	/ .70
-139, -293	lb.	1.45	/ 1.60
-182	lb.	2.00	/ 2.15
-186	lb.	1.40	/ 1.55
2246	lb.	1.50	/ 1.53
Anti Webbing Agent J-183	lb.	.75	/ .90
-297	lb.	.27	/ .40
Aquablak B	lb.	.0975	/ .1025
G	lb.	.12	/ .125
K	lb.	.12	/ .125
M	lb.	.105	/ .11
Aquarex D	lb.	.78	
G	lb.	.21	
L	lb.	.94	
MDL	lb.	.33	
ME	lb.	80	
Aquarex NS	lb.	$0.60	
SMO	lb.	.50	
WAQ	lb.	.22	
Areskap 50	lb.	.30	/ $0.38
100, dry	lb.	.60	/ .72
Aresket 240	lb.	.30	/ .38
300, dry	lb.	.60	/ .72
Aresklene 375	lb.	.42	/ .57
Ben-A-Gels	lb.	.98	/ 1.40
Bentone 18, 18C	lb.	.45	
34	lb.	.60	
Casein	lb.	.22	
Cellosize WP-09, -3, -40, -300	lb.	1.00	/ 1.17
CW-12	lb.	.85	
37	lb.	.70	
DC Antifoam A Compound	lb.	5.45	/ 6.65
Emulsion	lb.	2.05	/ 4.00
AF Emulsion	lb.	2.05	/ 2.85
Compound 7	lb.	5.13	/ 6.50
Defoama W-1701	lb.	.125	
Defoamer 115a	lb.	.50	
Dispersing Agents			
Blancol	lb.	.1525	/ .26
N	lb.	.155	/ .26
Darvan Nos. 1, 2, 3	lb.	.22	/ .30
Daxad 11, 21, 23, 27	lb.	.08	/ .30
Dispersaid H7A	lb.	.58	
1159	lb.	.43	
Empulphor ON-870	lb.	.50	/ .70
Igepal CO-630	lb.	.2875	/ .47
Igepon T-73	lb.	.285	/ .495
T-77	lb.	.45	/ .69
Indulins	lb.	.06	/ .08
Kreelons	lb.	.132	/ .15$_8$
Laurelton Oil	lb.	.18	
Leonil SA	lb.	.52	/ .65
Lomar PW	lb.	.18	
Marasperse CB	lb.	.1225	/ .14$_{25}$
N	lb.	.095	/ .10$_5$
Modicols	lb.	.17	/ .58
Nekal BA-75	lb.	.395	/ .54
BX-76	lb.	.63	/ .75
Orzan A	lb.	.0325	
S	lb.	.0425	
Pluronics	lb.	.335	/ .40
Polyfons	lb.	.08	/ .09
Sorapon SF-78	lb.	.28	/ .40
Tergitol NPX	lb.	.275	/ .30$_{74}$
TMN	lb.	.2875	/ .32
7	lb.	.4125	/ .44
Trenamine	lb.	.15	
Triton R-100	lb.	.12	/ .25
X-100, -102, -114	lb.	.255	/ .36
Dispersions			
Agebest 1293-22A	lb.	1.90	/ 2.00
AgeRite Alba	lb.	3.00	
Powder, Resin D	lb.	.80	
White	lb.	1.80	
Altax	lb.	.75	
Black No. 25	lb.	.22	
Shield Nos. 2, 6	lb.	.08	
3	lb.	.095	
4-35	lb.	.09	
5	lb.	.093	
7-F, 8	lb.	.165	
55	lb.	.18	
Iron Oxide, 60%	lb.	.40	
L.S.W.	lb.	1.50	
No. 305 Liquizinc	lb.	.30	/ .35
P-33	lb.	.35	
Rayox	lb.	.45	
Rotax	lb.	.75	
Sulfur	lb.	.12	/ .30
No. 2	lb.	.14	/ .16
Telloy	lb.	3.00	
Tuads, Methyl	lb.	1.60	
Vulcanizing, C group	lb.	.40	/ 1.30
G group	lb.	.45	/ .90
N group	lb.	.40	/ 1.00
Zetax	lb.	.75	
Zimates, Butyl	lb.	1.30	
Ethyl, Methyl	lb.	1.35	
Zinc oxide	lb.	.40	
Emulsions			
AgeRite Stalite	lb.	75	
Borden Arcco A-25, A-26, 716-30	lb.	.18	/ .19
555-40R	lb.	.185	/ .20$_5$
620-32B	lb.	.20	/ .21
716-35	lb.	.17	/ .18
1041-21	lb.	.165	/ .17$_5$
Habuco Resin Nos. 502, 515, 523	lb.	195	/ .20
503	lb.	.22	/ .22$_c$
504, 526	lb.	.19	/ .19$_c$
517	lb.	.175	/ .18
524	lb.	.155	/ 16
Resin A-2	lb.	.16	/ .25
P-370	lb.	.175	/ .25
X-210	lb.	.12	/ .22
Freeze-Stabilizer 322	lb.	.40	
12116C	lb.	.52	
Gelling Agent P-397	lb.	.34	/
Igepon T-43	lb.	.145	/ .35
T-51	lb.	.125	/ .28$_5$
-73	lb.	.285	/ .49$_5$
Indulins	lb.	.06	/ .08
Ludox	lb.	.1675	/ .19$_5$
Marmix	lb.	.41	/ .48
Merac	lb.	.75	/ 1.05
Micronex, colloidal	lb.	.06	/ .07$_2$
Monsanto Blue 4685 WD	lb.	1.60	
Green 4884 WD	lb.	1.80	
Red 127	lb.	1.25	
OPD-101	lb.	.16	/ .26
Picco Latex Plasticizer A-12	lb.	.069	/ .09$_6$
Pliolite Latex 150, 190	lb.	.32	/ .41
170	lb.	.37	/ .46
Polyvinyl methyl ether	lb.	$0.25	/ $0.45
Resin V	lb.	.13	
Roelgel 100C	lb.	.46	
Santomerse D	lb.	.44	/ .65
S	lb.	.13	/ .25
Sellogen Gel	lb.	.1275	
Sequestrene AA	lb.	.905	/ .975
30A	lb.	.245	/ .265
ST	lb.	.585	/ .615
Setsit #5	lb.	.75	/ 1.05
Stablex A	lb.	.80	/ 1.10
B, G	lb.	.50	/ .95
K	lb.	.27	/ .35
Stablex P	lb.	.35	/ .50
T	lb.	.14	/ .22
Surfactol 13	lb.	.345	/ .36
Webnix	lb.	1.50	/ 2.50

Mold Lubricants

Acintol D	lb.	.06	/ .075
A-C Polyethylene	lb.	.30	/ .37
Alipal CO-433	lb.	.25	/ .45
CO-436	lb.	.22	/ .41
Aquarex Compounds	lb.	.21	/ .94
Carbowax 200, 300, 400	lb.	.22	/ .25
1500	lb.	.255	/ .2825
4000	lb.	.31	/ .32
6000	lb.	.35	/ .36
Castorwax	lb.	.3375	/ .3575
Colite Concentrate	gal.	.90	/ 1.15
D-Tak Dip #10	gal.	1.50	
DC Mold Release Fluid	lb.	3.14	/ 4.75
Compound 4, 7	lb.	5.13	/ 6.50
Emulsion 7	lb.	1.59	/ 2.07
8, 35, 35A, 35B, 36	lb.	1.26	/ 1.80
200 Fluid	lb.	3.14	/ 4.75
ELA	lb.	.82	
FT Wax 200	lb.	.265	/ .42
300	lb.	.295	/ .45
Glycerized Liquid Lubricant, concentrated	gal.	1.25	/ 1.63
Igepals	lb.	.2875	/ .74
Igepon AP-78	lb.	.44	/ .68
T-43	lb.	.145	/ .35
-51	lb.	.125	/ .285
-73	lb.	.285	/ .495
Lubrex	lb.	.27	/ .32
Lubri-Flo	gal.	10.00	/ 12.05
Lustermold	lb.	.41	
L-41 Diethyl Silicone Oil	lb.	3.50	
Mold Paste	lb.	.25	
Monopole Oil	lb.	.16	
Monten Wax	lb.	.57	
Para Lube	lb.	.046	/ .048
Plaskon 8406, 8407	lb.	.30	/ .37
8416, 8417	lb.	.35	/ .42
8429	lb.	.40	/ .47
Pluronics	lb.	.335	/ .44
Polyglycol E series	lb.	.29	/ .42
RA-1, -2, -3	gal.	2.25	/ 3.00
Rubber-Glo	gal.	.94	/ .97
SM-33, -55, -61, -62	lb.	1.22	/ 1.76
Soap, Hawkeye	lb.	1.35	/ 1.45
Purity	lb.	.155	/ .165
Sodium stearate	lb.	.40	
Stoner's 700 series	gal.	1.20	/ 1.25
800 series	gal.	1.26	/ 1.70
900 series	gal.	1.55	/ 2.55
A Series	gal.	1.80	/ 4.50
Ucon 50-HB Series	lb.	.25	/ .375
Ulco	lb.	.12	/ .23
Vanfre	gal.	2.50	/ 3.00

Odorants

Alamasks	lb.	.75	/ 6.50
Coumarin	lb.	2.95	/ 3.55
Curodex 19	lb.	4.75	/ 5.05
188	lb.	5.75	
198	lb.	6.75	
Ethavan	lb.	6.75	/ 7.35
Latex Perfume #7	lb.	4.00	
Neutroleum Gamma	lb.	3.60	
Rubber Perfume #10	lb.	2.60	
Vanillin, Monsanto	lb.	3.00	/ 3.15

Plasticizers and Softeners

Acintol R	lb.	.065	/ .07
Adipol 2EH, 10A	lb.	.40	/ .435
BCA	lb.	.43	/ .455
ODY	lb.	.45	/ .485
Admex 710	lb.	.325	
711	lb.	.345	
744	lb.	.40	
Aro Lene #1980	lb.	.10	/ .12
Baker AA Oil	lb.	.195	/ .24
Crystal O Oil	lb.	.21	/ .255
Processed oils	lb.	.215	/ .235
Bardol, 639	lb.	.215	/ .235
B	lb.	.0625	/ .065
Benzoflex 2-45	lb.	.26	/ .29
9-88	lb.	.27	/ .30
Bondogen	lb.	.55	/ .60
BRC 20	lb.	.15	/ .175
22	lb.	.025	/ .0275
30	lb.	.0125	/ .021
521	lb.	.019	/ .02
BRH 2	lb.	.0213	/ .0351
BRS 700	lb.	.02	/ .0285
BRT 7	lb.	.03	/ .031
BRV	lb.	.0475	/ .0565
Bunarex Liquid	lb.	.0425	/ .0553
Resins	lb.	.065	/ .1225
Bunnatol G, S	lb.	.40	/ .505
Butac	lb.	.125	/ .135
Butyl stearate, commil	lb.	.255	
Binney & Smith	lb.	.23	/ .26
Hardesty	lb.	.23	/ .26
Ohio-Apex	lb.	.22	/ .255
Cabflex HS-10	lb.	.44	/ .47

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G. P.	lb.	$0.0125/ $0.02
R-100	lb.	.045 / .0525
T T	lb.	.017 / .0245
Capryl alcohol, comml.	lb.	.195 / .235
Binney & Smith	lb.	.18 / .28
Hardesty	lb.	.18 / .28
Chlorowax 40	lb.	.1625/ .1825
70	lb.	.185 / .245
-S	lb.	.21 / .27
Circo light	gal.	.17
Circosol-2XH	gal.	.185
Contogums	lb.	.0875/ .111
Cumar Resins	lb.	.065 / .17
DBM (dibutyl-m-cresol)		
Darex	lb.	.32 / .3475
DBP (dibutyl phthalate), comml.	lb.	.30 / .33
Darex	lb.	.30 / .33
Eastman	lb.	.30 / .33
Hatco	lb.	.30 / .33
Monsanto	lb.	.30 / .33
Naugatuck	lb.	.30 / .33
Ohio-Apex	lb.	.30 / .335
PX-104	lb.	.30 / .33
Rubber Corp. of America	lb.	.30 / .44
Sherwin-Williams	lb.	.30 / .33
DBS (dibutylsebacate), comml.	lb.	.66 / .69
Hatco	lb.	.66 / .685
Monoplex	lb.	.66 / .675
Naugatuck	lb.	.665 / .69
PX-404	lb.	.665 / .69
DPC (dicaprylphthalate), comml.	lb.	.295 / .325
Hatco	lb.	.295 / .325
Monoplex	lb.	.30 / .315
DDA (didecyladipate)		
Cabflex	lb.	.425 / .455
Good-rite GP-236	lb.	.40 / .55
DDP (didecylphthalate)		
Cabflex	lb.	.305 / .335
Good-rite GP-266	lb.	.295 / .45
Hatco	lb.	.305 / .435
Defoamer X-3		.355
DIBA (diisobutyladipate)		
Cabflex	lb.	.4325/ .4625
Darex	lb.	.4325/ .4625
Eastman	lb.	.41 / .44
Ohio-Apex	lb.	.41 / .445
DIDA (diisodecyladipate)		
Monsanto	lb.	.425 / .455
DIDP (diisodecylphthalate)		
Darex	lb.	.32 / .35
Monsanto	lb.	.305 / .335
Ohio-Apex	lb.	.295 / .33
PX-120	lb.	.305 / .335
Dielex B	lb.	.06
Diethylene glycol, comml.	lb.	.1525/ .1825
Wyandotte	lb.	.15 / .165
Dinopol IDO	lb.	.29 / .325
DIOA (diisooctyladipate)		
Cabflex	lb.	.425 / .455
Naugatuck	lb.	.435 / .465
PX-208	lb.	.425 / .455
Rubber Corp. of America	lb.	.425 / .56
DIOP (diisooctylphthalate), comml.	lb.	.305 / .335
Cabflex	lb.	.305 / .335
Darex	lb.	.32 / .35
Eastman	lb.	.305 / .335
Hatco	lb.	.305 / .335
Monsanto	lb.	.305 / .335
Naugatuck	lb.	.305 / .335
Ohio-Apex	lb.	.285 / .32
PX-108	lb.	.305 / .335
Rubber Corp. of America	lb.	.305 / .45
Sherwin-Williams	lb.	.32 / .34
DIOS (diisooctylsebacate), comml.	lb.	.61 / .64
Rubber Corp. of America	lb.	.61 / .84
DIOZ (diisooctylazelate)		
Cabflex	lb.	.48 / .51
Dipolymer Oil	gal.	.33 / .38
Dispersing Oil No. 10	lb.	.06 / .0625
DNODP (di-n-octyl-n-decyl phthalate), Monsanto	lb.	.345 / .375
DOA (dioctyladipate), comml.	lb.	.425 / .455
Cabflex	lb.	.425 / .455
Eastman	lb.	.40 / .43
Good-rite GP-233	lb.	.40 / .55
Hatco	lb.	.435 / .465
Monsanto	lb.	.425 / .455
Naugatuck	lb.	.435 / .465
PX-238	lb.	.425 / .455
Rubber Corp. of America	lb.	.425 / .56
DOP (dioctylphthalate), comml.	lb.	.305 / .335
Cabflex	lb.	.305 / .335
Darex	lb.	.32 / .35
Eastman	lb.	.305 / .335
Good-rite GP-261	lb.	.285 / .44
Hatco	lb.	.305 / .335
Monsanto	lb.	.305 / .335
Naugatuck	lb.	.305 / .335
Ohio-Apex	lb.	.285 / .32
Polycizer 162	lb.	.28 / .435
PX-138	lb.	.305 / .335
Rubber Corp. of America	lb.	.305 / .45
Sherwin-Williams	lb.	.305 / .335
DOS (dioctylsebacate), comml.	lb.	.61 / .64
Eastman	lb.	.61 / .64
Hatco	lb.	.61 / .635
Monoplex	lb.	.61 / .635
Naugatuck	lb.	.615 / .64
PX-438	lb.	.615 / .64
Rubber Corp. of America	lb.	.61 / .84
Drapex 3.2	lb.	.40 / .54
Dutch Boy NL-A10 (DBP)	lb.	$0.30 / $0.33
-A20 (DOP), A30 (DIOP)	lb.	.305 / .335
-A54	lb.	.295 / .325
-C20 (DOS)	lb.	.61 / .63
-F21	lb.	.395 / .425
-F31	lb.	.44 / .47
-F41	lb.	.48 / .51
Dutrex 6	lb.	.025 / .035
Dymerex Resin	lb.	.135 / .1475
Emulphor EL-719	lb.	.52 / .73
Endor	lb.	.65
Ethox	lb.	.43 / .455
Ethylene glycol, comml.	lb.	.135 / .165
Wyandotte	lb.	.1325/ .1425
Flexol 3 GH	lb.	.44 / .46
3 GO	lb.	.53 / .55
4 GO	lb.	.325 / .355
10-A	lb.	.425 / .455
426	lb.	.27 / .30
810, 810X, 10-10, 10-10X	lb.	.305 / .335
TOF, A-26	lb.	.435 / .465
Flexricin P-4	lb.	.3475/ .3625
P-6	lb.	.415 / .43
P-8	lb.	.3475/ .3625
PG-16	lb.	.335 / .35
Fortex	lb.	.125 / .145
G. B. Asphaltic Flux	gal.	.08 / .14
Naphthenic Neutrals	gal.	.11 / .18
Process oil, light	lb.	.025 / .0325
Medium	lb.	.035 / .0425
Galex W-100	lb.	.155 / .18
W-100 D	lb.	.1525/ .1775
Gilsowax B	lb.	.0975/ .11
Harchemex	lb.	.25 / .34
Harflex 10	lb.	1.25 / 1.335
40	lb.	.64 / .725
50, 80, 300	lb.	.58 / .665
60	lb.	.62 / .705
90	lb.	.88 / .965
120, 150	lb.	.305 / .395
140, 160	lb.	.30 / .33
180	lb.	.295 / .38
220, 250	lb.	.425 / .515
260	lb.	.42 / .45
280	lb.	.42 / .51
500	lb.	.315 / .41
HB-20	lb.	.15 / .17
-40	lb.	.19 / .21
Heavy Resin Oil	lb.	.0225/ .0375
HSC-13	lb.	.25 / .32
-39	lb.	.22 / .29
Hycar 1312	lb.	.60
Indonex	gal.	.11 / .19
Kapsol	lb.	.33 / .355
Kenflex A, L	lb.	.26 / .27
B	lb.	.23 / .24
N	lb.	.18 / .19
Kessoflex 103	lb.	.405
105	lb.	.3325
106	lb.	.38
107	lb.	.525
110	lb.	.24
111	lb.	.28
KP-23	lb.	.29 / .325
-90	lb.	.40 / .435
-140	lb.	.46 / .485
-201	lb.	.58 / .59
-220	lb.	.32 / .355
-555	lb.	.565 / .57
Kronisol	lb.	.33 / .365
Kronitex AA, I, K-3, Mx	lb.	.325 / .36
LX-685, -125, -135	lb.	.125 / .135
Marvinol plasticizers	lb.	.28 / .8825
Methox	lb.	.385 / .41
Monoplex S-38	lb.	.215 / .24
S-71	lb.	.45 / .475
Morflex	lb.	.25 / .65
Natac	lb.	.12 / .13
Neoprene Peptizer P.-12	lb.	1.05
Nevillac	lb.	.31 / .85
Neville R Resins	lb.	.145 / .205
Nevinol	lb.	.24
No. 1-D heavy oil	lb.	.065
ODA (octyldecyladipate) Cabflex	lb.	.425 / .455
Good-rite GP-235	lb.	.40 / .55
ODP (octyldecylphthalate) Cabflex	lb.	.305 / .335
Good-rite GP-265	lb.	.29 / .445
Hatco	lb.	.305 / .335
Rubber Corp. of America	lb.	.305 / .45
Ohopex Q-10	lb.	.295 / .33
R-9	lb.	.3525/ .3775
Orthonitro benzophenol, comml.	lb.	.13 / .15
Monsanto	lb.	.13 / .15
Palmalene	lb.	.15
Panaflex BN-1	lb.	.185 / .225
Para Flux, regular	gal.	.10 / .2125
No. 2016	gal.	.165 / .24
2332	gal.	.11
4205	lb.	.1075/ .2125
Para Lube	lb.	.046 / .048
Resins	lb.	.04 / .045
Paradene Resins	lb.	.07 / .08
Paraplex 5-B	lb.	.29 / .3475
AL-111	lb.	.32 / .3275
G-25	lb.	.76 / .77
-40	lb.	.4825/ .51
-50	lb.	.39 / .4175
-53	lb.	.4325/ .46
-60	lb.	.325 / .35
-62	lb.	.345 / .37
RG-7	lb.	.33 / .335
-8	lb.	.505 / .5125
-10	lb.	.52 / .5275
Pepton 22	lb.	.81 / .84
65	lb.	1.20 / 1.23
65-B	lb.	.81 / .84
Philrich 5	gal.	.11
Picco Resins	lb.	$0.135 / $0.195
480 Oilproof Series	lb.	.18 / .23
Aromatic Plasticizers	lb.	.05 / .065
Liquid Resin D-165 (Y)	lb.	.06 / .075
(Z-3)	lb.	.07 / .085
(Z-6)	lb.	.08 / .095
S. O. S.	gal.	.29 / .34
Piccocizers	lb.	.04 / .055
Piccolastic Resins	lb.	.1855/ .34
Piccolyte Resins	lb.	.185 / .25
Piccopale Resins	lb.	.12 / .135
Piccovars	lb.	.165 / .20
Piccovol	lb.	.025 / .038
Pictar	gal.	.25 / .30
Pigmentar	lb.	.046 / .0745
Pigmentaroil	lb.	.046 / .0745
Pine Tar, Sunny South	lb.	.046 / .0801
Oil, Sunny South	lb.	.046 / .0801
Pitch, Burgundy, Sunny South	lb.	.1030/ .1085
Plasticizers 42	lb.	.34 / .40
B	lb.	.35 / .45
DP-520	lb.	.435 / .455
MP	lb.	.035 / .0755
MT-511	lb.	.6925/ .7425
ODN	lb.	.35 / .475
SC	lb.	.40 / .515
Plastoflex #3	lb.	.52 / .57
#520	lb.	.36 / .435
DBE	lb.	.50 / .55
MGB	lb.	.29 / .37
SP-2	lb.	.43 / .48
VS	lb.	.3575/ .3975
Plastogen	lb.	.0775/ .08
Plastone	lb.	.25 / .32
Polycin 470	lb.	.325 / .34
Polycizers	lb.	.28 / .55
162	lb.	.285 / .44
Polymel D	lb.	.225 / .235
C-128	lb.	.1775/ .1875
D-TAC	lb.	.1975/ .215
DX, C-130	lb.	.1375/ .1475
PT67 Light Pine Oil	gal.	.60
101 Pine Tar Oil	lb.	.046 / .0634
Pine Tars	lb.	.046 / .0634
Reogen	lb.	.1325/ .135
Resin C pitch	lb.	.0225/ .031
R6-3	lb.	.38 / .40
Resinex 10, 25, 50, 110	lb.	.04 / .045
70	lb.	.0325/ .0375
85, 100	lb.	.035 / .04
115	lb.	.0375/ .0425
L-2, L-3, L-4, L-5	lb.	.0225/ .03
Rosin Oil, Sunny South	gal.	.58 / .875
RPA No. 2	lb.	.82
3	lb.	.48
Conc.	lb.	.85
5	lb.	.68
6	lb.	1.62
RSN Flux	gal.	.10 / .91
Rubber Oil B-5	lb.	.0225/ .0355
Rubberol	lb.	.18 / .2725
Santicizer 1-H	lb.	.50 / .51
3	lb.	.46 / .47
8	lb.	.43 / .44
9	lb.	.39 / .42
140	lb.	.325 / .36
141	lb.	.34 / .37
160	lb.	.25 / .28
601	lb.	.325
602	lb.	.305
B-16	lb.	.4875/ .4975
E-15	lb.	.5075/ .5375
M-17	lb.	.4275/ .4575
Sebacic acid, purified, comml.	lb.	.59 / .65
Binney & Smith	lb.	.64 / .76
Hardesty	lb.	.64 / .76
C.P.-Binney & Smith	lb.	.72 / .84
Hardesty	lb.	.72 / .84
Sherolatum Petrolatum	lb.	.05 / .10
Softener #20	gal.	.10 / .20
Special Rubber Resin 100	lb.	.1675/ .2175
Staflex AX	lb.	.43
DBES	lb.	.61 / .635
Syn-Tac	gal.	.33 / .35
Synthol	lb.	.17 / .2625
Thiokol TP-90B	lb.	.59
-95	lb.	.65
Tricresyl phosphate, comml.	lb.	.33 / .36
Cabflex	lb.	.345 / .375
Monsanto	lb.	.325 / .36
Naugatuck	lb.	.33 / .36
PX-917	lb.	.33 / .36
Triphenyl phosphate, comml.	lb.	.39 / .40
Monsanto	lb.	.39 / .40
Turgum S	lb.	.1075/ .1175
Tysonite	lb.	.24 / .2475
United	gal.	.69 / 1.20
X-1 Resinous Oil	lb.	.0225/ .0325

Reclaiming Oils

Acintol C, P	lb.	.02 / .03
Bardol, 639	lb.	.0275/ .0375
B	lb.	.0625/ .065
BRH 2	lb.	.0213/ .0351
BRT 3	lb.	.018 / .0265
4	lb.	.025 / .026
7	lb.	.03 / .031
BRV	lb.	.0475/ .0565
Burco-RA	lb.	.053 / .0805
BWH-1	lb.	.16 / .18
Dipolymer Oil	gal.	.33 / .43
Dispersing Oil No. 10	lb.	.06 / .0625
G. B. Oils	gal.	.10 / .24
Heavy Resin Oil	lb.	.0225/ .0375

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-759	gal.	.1375	
-777, -809, -859	gal.	.23 /	.33
-869	gal.	.33 /	.43
-871	gal.	.34 /	.44
No. 3186	gal.	.28 /	.295
Picco 6535	gal.	.25 /	.30
C-33	gal.	.215 /	.315
-42	gal.	.23 /	.33
D-4	gal.	.27 /	.37
E-5	gal.	.25 /	.35
Q-Oil	gal.	.286 /	.36
PT 67	gal.	.60	
101 Pine Tar Oil	lb.	.0427/	.0610
150 Pine Solvent	gal.	.44	
Reclaiming Oil #3186	gal.	.28 /	.385
-G	gal.	.25 /	.365
4039-M	gal.	.3275/	.3975
-V	gal.	.30 /	.37
RR-10	lb.	.37	
S. R. O.	lb.	.015 /	.0225
X-1 Resinous Oil	lb.	.0225/	.0325
Reinforcers, Other Than Carbon Black			
Angelo Shellacs	lb.	.485 /	.7325
Borden, Chem. Div.			
Arcco 978-42B	lb.	.18 /	.19
1073-18B	lb.	.135 /	.145
1294-36B	lb.	.115 /	.125
1301-12B	lb.	.15 /	.16
BRC 20	lb.	.15 /	.175
22	lb.	.025 /	.0275
30	lb.	.0125/	.021
521	lb.	.019 /	.02
Bunarex Resins	lb.	.065 /	.1225
Cab-o-sil	lb.	.68 /	.75
Calcene NC	ton	72.50 /	92.50
TM	ton	75.00 /	95.00
Calco S. A.	lb.	.85 /	.88
Clays			
Aiken	ton	14.00	
Aluminum Flake	ton	22.25 /	60.00
Buca	ton	45.00	
Burgess Iceberg	ton	50.00 /	80.00
Icecap K	ton	65.00 /	90.00
Pigment #20	ton	35.00 /	60.00
30	ton	37.00 /	60.00
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Crown	ton	14.00 /	33.00
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L. G. B.	ton	17.00	
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Pigment No. 33	ton	37.00	
Recco	ton	14.00	
Suprex	ton	14.00 /	33.50
Swanee	ton	12.50	
Whitetex	ton	50.00	
Windsor	ton	14.00 /	30.00
Witco No. 1	ton	14.00 /	30.00
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Clearcarb	lb.	.1175/	.1255
Cumar Resins	lb.	.065 /	.17
Darex Resins	lb.	.42 /	.49
DC Silica	lb.	1.45 /	1.65
Diatomaceous silica	ton	32.00 /	48.00
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K Series Polymers	lb.	.15 /	.37
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233	lb.	.09 /	.105
X303	lb.	.40 /	.45
Hycar 2001	lb.	.55	
2007	lb.	.39	
Indulins	lb.	.06 /	.08
Kralac A-EP	lb.	.43 /	.54
Laminar	ton	30.00	
Magnesium carbonate, Merck	lb.	.105 /	.12
Marbon Resins	lb.	.39 /	.46
Multifex MM	ton	110.00 /	125.00
Super	ton	160.00 /	175.00
Neville Resins			
465	lb.	.075 /	.08
LX-509	lb.	.33 /	.35
Nebony	lb.	.045 /	.05
Paradene	lb.	.07 /	.08
R	lb.	.145 /	.205
Para Resins 2457, 2718	lb.	.04 /	.4575
Parapol S-Polymers	lb.	.44	
Picco Resins	lb.	.13 /	.225
Piccolyte Resins	lb.	.205 /	.275
Piccoumaron Resins	lb.	.07 /	.19
Piccovars	lb.	.145 /	.20
Pliolite NR types	lb.	.98 /	1.33
S-3, -6	lb.	.42 /	.49
-6B	lb.	.39 /	.46
Plio-Tuf G85C	lb.	.52 /	.59
Purecal M	ton	56.75 /	71.75
SC, T	ton	110.00 /	125.00
U	ton	120.00 /	135.00
R-B-H 510	lb.	.15 /	.22
Resinex	lb.	.0325/	.0425
Rubber Resin LM-4	lb.	.28 /	.35
Silene EF	ton	120.00 /	140.00
Silvacons	ton	55.00 /	85.00
Witcarb R	ton	105.00 /	120.00
-12	ton	45.00 /	66.00
Zeolex 23	ton	120.00 /	140.00
Zinc oxide, commercial†	lb.	.135 /	.1775
Retarders			
Benzoic acid TBAO-2	lb.	.44 /	
E-S-E-N	lb.	.37 /	.39
Good-rite Vultrol	lb.	.62 /	.66
R-17 Resin	lb.	.1075/	.36
Retarder ASA	lb.	.57	
J	lb.	.62 /	.64
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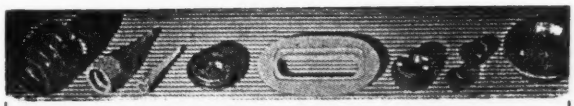
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Butyrolactone	lb.	.60 /	.65
Cosol #1	gal.	.37 /	.43
#2	gal.	.42 /	.48
Dichloro Pentanes	lb.	.04 /	.07
Dipentene DD, Sunny South	gal.	.40 /	.62
Ethylene dichloride, comml.	lb.	.09 /	.1225
Hi-Flash 2-50-W	gal.	.41	
Pale yellow	gal.	.39	
LX-572	gal.	.27 /	.32
-748	gal.	.16 /	.23
Methyl-2-pyrrolidone	lb.	.75 /	.80
Neville Nos. 100, 104	gal.	.52 /	.60
106	gal.	.38 /	.46
Nevsolv H, 200	gal.	.19 /	.29
HF, T, 30	gal.	.24 /	.34
Penetrell	gal.	.40 /	.62
Picco Hi-Solv Solvents	gal.	.16 /	.48
Pine Oil DD, Sunny South	lb.	.1225/	.1425
PT 150 Pine Solvent	gal.	.44	
Skellysolve-B	gal.	.17	
-H	gal.	.148	
-R, -V	gal.	.139	
-C	gal.	.162	
Stauffer Carbon Disulphide	lb.	.0525/	.085
Tetrachloride	lb.	.0825/	.475

Synthetic Rubber Monomers

Dow Styrene N99, H99	lb.	.205	
RG	lb.	.17	
Vinyltoluene	lb.	.17	
Hylene M	lb.	3.50 /	5.00
M-50	lb.	1.90 /	3.40
T	lb.	1.10 /	2.65
TM	lb.	.95 /	2.50
-65	lb.	1.00 /	2.55
Monomer MG-1	lb.	1.00 /	1.25
Mondur-C	lb.	1.05	
-S	lb.	.85	
Multron R-2	lb.	.54	
Rohm & Haas ethyl acrylate	lb.	.34 /	.36
Glacial methacrylic acid	lb.	.45 /	.47
Methyl acrylate	lb.	.37 /	.39
Methacrylate	lb.	.29 /	.31

Synthetic Rubber Shortstops

DDM	lb.	.75 /	.88
Mercaptan 174	lb.	.38 /	.50
Shortstop 204	lb.	.33 /	.37
268	lb.	.52 /	.53
Tecquinol	lb.	.825 /	.845
Thiostop K	lb.	.53	
N	lb.	.41	

Tackifiers

Acintol R	lb.	.065 /	.07
Bardol, 639	lb.	.0275/	.0375
Borden, Arcco A25, A26, 716-30	lb.	.18 /	.19
555-40R	lb.	.185 /	.205
620-32B	lb.	.20 /	.21
716-35	lb.	.17 /	.18
1041-21	lb.	.165 /	.175
BRH 2	lb.	.0213/	.0351
Bunarex Resins	lb.	.065 /	.1225
Chlorowax 70	lb.	.18 /	.24
Contogums	lb.	.0875/	.11
Cumar Resins	lb.	.065 /	.17
Galex W-100	lb.	.155 /	.17
W-100D	lb.	.1525/	.1625
Indopol H-35	gal.	.65 /	.81
H-50	gal.	.70 /	.86
-100	gal.	.85 /	1.05
-300	gal.	1.00 /	1.21
L-10	gal.	.40 /	.56
-50	gal.	.45 /	.61
-100	gal.	.55 /	.71
Kenflex resins	lb.	.18 /	.27
Koresin	lb.	.90 /	1.10
Natac	lb.	.12 /	.13
Nevindene	lb.	.15 /	.18
Picco Resins	lb.	.13 /	.185
Piccolastic Resins	lb.	.1855/	.34
Piccolyte Resins	lb.	.185 /	.25
Piccopale Resins	lb.	.089 /	.13
Piccoumaron Resins	lb.	.07 /	.185
R-B-H 510	lb.	.15 /	.22
Roelflex 1118A	lb.	.39	
Synthetic 100	lb.	.41	
Synthol	lb.	.17 /	.2625
United	gal.	.69 /	1.20

Vulcanizing Agents

Dibenzo G-M-F	lb.	2.60	
G-M-F #113, #117	lb.	.90	
HMDA-Carbamate	lb.	4.50 /	4.90
Ko-Blend I, S	lb.	.39	
Litharge (*See Accelerator-Activators, Inorganic*)			
Magnesium oxide	lb.	.2525/	.38
Merck, Light Calcined	lb.	.2525/	.26
Extra Light Calcined	lb.	.2925/	.30
Red Lead (*See Accelerator-Activators, Inorganic*)			
Sulfasan R	lb.	1.50	
Sulfur flour, comml.	100 lbs.	2.55 /	3.30
Aero	100 lbs.	2.40 /	7.75
Crystex	lb.	.195 /	.23
Insoluble 60	lb.	.15 /	.155
Rubbermakers	100 lbs.	2.65 /	4.55
Stauffer	lb.	.0265/	.054
Telloy	lb.	2.50	
VA-7	lb.	.50 /	.60
Vandex	lb.	15.50	
Vultac No. 2	lb.	.47 /	.755
3	lb.	.51 /	.795
White lead silicate (*See Accelerator-Activators, Inorganic*)			

Index to Advertisers

This index is maintained for the convenience of our readers. It is not part of the advertisers' contract, and RUBBER WORLD assumes no responsibility to advertisers for its correctness.

A

Adamson United Co. ... —
Aetna-Standard Engineering Co. ... 808
Akron Rubber Machinery Co., Inc., The ... 967
Albert, L., & Son ... 965
Alco Oil & Chemical Corp. ... —
Allis-Chalmers Mfg. Co. ... 856, 857
Aluminum Flake Co. ... 967
American Cyanamid Co., Rubber Chemicals Dept. ... 955
American Synthetic Rubber Corp. ... 931
American Zinc Sales Co. ... —
Ames, B. C., Co. ... —

B

Barco Manufacturing Co. ... 970
Barr Rubber Products Co., The ... 969
Black Rock Mfg. Co. ... 947
Bolling, Stewart, & Co., Inc. ... —
Borden Co., The, Chemical Division ... —
Brockton Tool Co. ... 965
Brooklyn Color Works, Inc. ... —
Burgess Pigment Co. ... 820

C

Cabot, Godfrey L., Inc. ... Back Cover
Carbide & Carbon Chemicals Co., A Division of Union Carbide & Carbon Corp. ... 854
Carey, Philip, Mfg. Co., The ... —
Carter Bell Mfg. Co., The ... 852
Cary Chemicals, Inc. ... 826
Celanese Corp. of America ... —
Claremont Waste Mfg. Co. ... 951

CLASSIFIED ADVERTISEMENTS ... 963, 965, 967, 969
Cleveland Liner & Mfg. Co., The ... Third Cover
Columbia-Southern Chemical Corp. ... 943
Columbia Carbon Co. ... Insert 901, 902
Mapico Color Unit ... 836
CONSULTANTS & ENGINEERS ... 969
Continental Carbon Co. ... 935
Continental Machinery Co., Inc. ... —
Copolymer Rubber & Chemical Corp. ... 831

D

Darlington Chemicals, Inc. ... 949
Dayton Rubber Co., The ... 949
Diamond Alkali Co. ... 804
Dow Chemical Co., The ... 961
Dow Corning Corp. ... 940
DPR, Incorporated, A Subsidiary of H. V. Hardman Co. ... 948
du Pont de Nemours, E. I., & Co. ... Second Cover
Durez Plastics Division Hooker Electrochemical Co. ... 816

E

Eagle-Picher Co., The ... 947
Enjay Co., The ... 927
Erie Engine & Mfg. Co. ... 836
Erie Foundry Co. ... —
Esso Research & Engineering Co. ... 963
Executive Service Corp. ... 965

F

Falls Engineering & Machine Co., The 828, 829
Farrel-Birmingham Co., Inc. ... 861
Ferry Machine Co. ... —
Flexo Supply Co., The ... —
French Oil Mill Machinery Co., The ... —

G

Gale, C. J. ... 969
Gammeter, W. F., Co., The ... 967
General Latex & Chemical Corp. ... 840
General Magnesite & Magnesia Co. ... —
General Tire & Rubber Co., The (Chemical Division) ... 862, 863
Genseke Brothers ... —
Gidley Research Institute ... 969
Glidden Co., The (Chemicals, Pigments, Metals Division) ... 835
Goodrich, B. F., Chemical Co. ... 805
Goodrich-Gulf Chemicals, Inc. ... 855
Goodyear Tire & Rubber Co., Inc., The (Chemical Division) ... 809, 811, 813, 933

H

Hale & Kullgren, Inc. ... 808, 969
Hall, C. P., Co., The ... 806
Hanchett Manufacturing Co. ... 840
Harchem Division, Wallace & Tiernan, Inc. 814
Harwick Standard Chemical Co. ... 833
Hercules Powder Co. ... —
Hoggson & Pettis Mfg. Co., The ... 852
Holliston Mills, Inc., The ... 848
Holmes, Stanley H., Co. ... 945
Howe Machinery Co., Inc. ... 965
Huber, J. M., Corp. ... 864

I

Iddon Brothers, Ltd. ... —
Independent Die & Supply Co. ... 945
Industrial Ovens, Inc. ... —
Institution of the Rubber Industry ... —

J

Jefferson Chemical Co., Inc. ... —
Johnson Corp., The ... —

K

K. B. C. Industries, Inc. ... 969
Kellogg, M. W., Co., The ... —
Kingsbacher-Murphy Co. ... 946
Koppers Co., Inc. (Chemical Division) ... —

L

Lambert, E. P., Co. ... —
Liquid Carbonic Corp. ... 937

M

Mapico Color Unit, Columbian Carbon Co. 836
Marbon Chemical, Division of Borg-Warner Corp. ... 812
McNeil Machine & Engineering Co., The Insert 919-922
Merck & Co., Inc. Marine Magnesium Division ... 854
Monsanto Chemical Co. ... 839
Morris, T. W., Trimming Machines ... 848
Muehlstein, H., & Co., Inc. ... 815
Mumper, James F., Co., The ... 969

N

National Aniline Division, Allied Chemical & Dye Corp. ... 851
National Rubber Machinery Co. ... 929
National Standard Co. ... 810
Naugatuck Chemical Division of U. S. Rubber Co. ... 807, 959
Neville Chemical Co. ... 825
New Jersey Zinc Co., The ... 817
Nopco Chemical Co. ... 818

O

Oakite Products, Inc. ... 951
Osborn Manufacturing Co., The ... 968

P

Pacific Transducer Corp. ... 946
Pennsylvania Industrial Chemical Corp. ... —
Pequanoc Rubber Co. ... 824, 969
Phillips Chemical Co. ... Insert 859, 860
Polychemical Division, West Virginia Pulp & Paper Co. ... —
Polymer Corp., Ltd. ... —

R

Rand Rubber Co. ... —
Rare Metal Products Co. ... 967
Rhodia, Inc. ... —
Richardson, Sid, Carbon Co. ... 972
Royle, John, & Sons ... 834
Rubber Corp. of America ... 950
Rubber Regenerating Co., Ltd., The ... —

S

St. Joseph Lead Co. ... —
Sargent's, C. G., Sons Corp. ... 838
Schlosser, H. A., & Co. ... 967
Scott Testers, Inc. ... 967
Scoville Manufacturing Co. ... —
'Sharples' brand Chemicals, Pennsylvania Salt Mfg. Co. ... 939
Shaw, Francis, & Co., Ltd. ... 832
Shell Chemical Corp., Synthetic Rubber Sales Division ... 837
Shell Oil Co. ... 845
Sherman Rubber Machinery Co. ... 965
Shore Instrument & Manufacturing Co., Inc., The ... 965
Siempelkamp, G., & Co. ... 847
Silicones Division, Union Carbide & Carbon Corp. ... 849
South Texas Tire Test Fleet, Inc. ... 948
Southeastern Clay Co. ... 952
Southern Clays, Inc. ... —
Spadone Machine Co., Inc. ... 850
Stamford Rubber Supply Co., The ... 834
Sun Oil Co. ... 924, 925

T

Taylor Instrument Cos. ... 841
Taylor, Stiles & Co. ... —
Thiokol Chemical Corp. ... 842, 843
Thomaston Mills ... 953
Timken Roller Bearing Co., The ... 823
Titanium Pigment Corp. ... 858
Torrington Co., The ... 853
Turner Halsey Co. ... 846

U

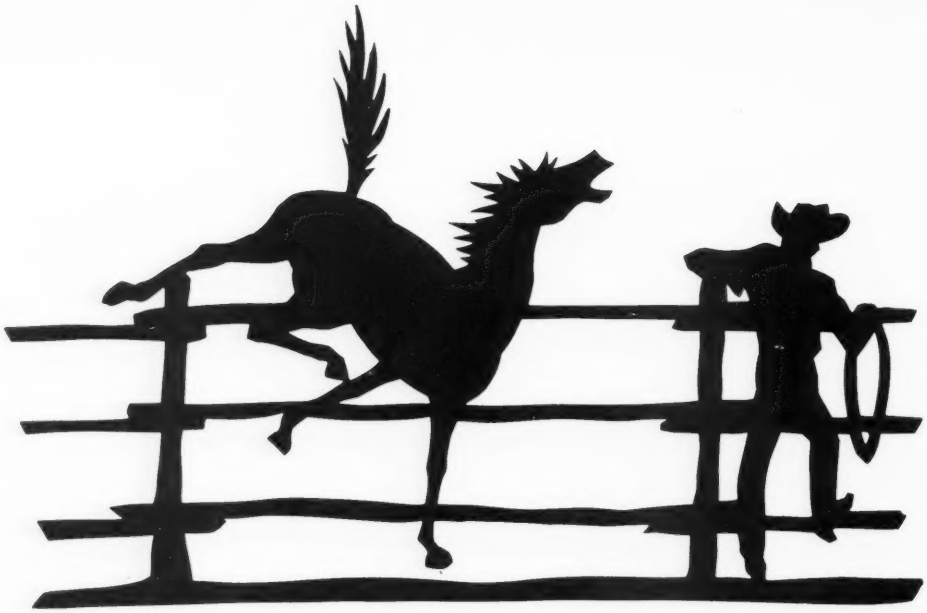
Union Carbide & Carbon Corp., Carbide & Carbon Chemicals Co. ... 854
Union Carbide & Carbon Corp., Silicones Division ... 849
United Carbon Co., Inc. ... Insert 821, 822
United Engineering & Foundry Co. ... —
United Rubber Machinery Exchange ... 965
U.S. Rubber Reclaiming Co., Inc. ... —
Universal Oil Products Co. ... 819

V

Vanderbilt, R. T., Co., Inc. ... 866
Velsicol Chemical Corp. ... —

W

Wade, L. C., Co., Inc. ... —
Wellington Sears Co. ... 957
Wellman Co. ... —
Westinghouse Electric Corp., Sturtevant Division ... 844
White, J. J., Products Co. ... —
Whittaker, Clark & Daniels, Inc. ... —
Williams, C. K., & Co., Inc. ... 838
Witco Chemical Co. ... 935
Woloch, George, Co., Inc. ... —
Wood, R. D. Co. ... 827



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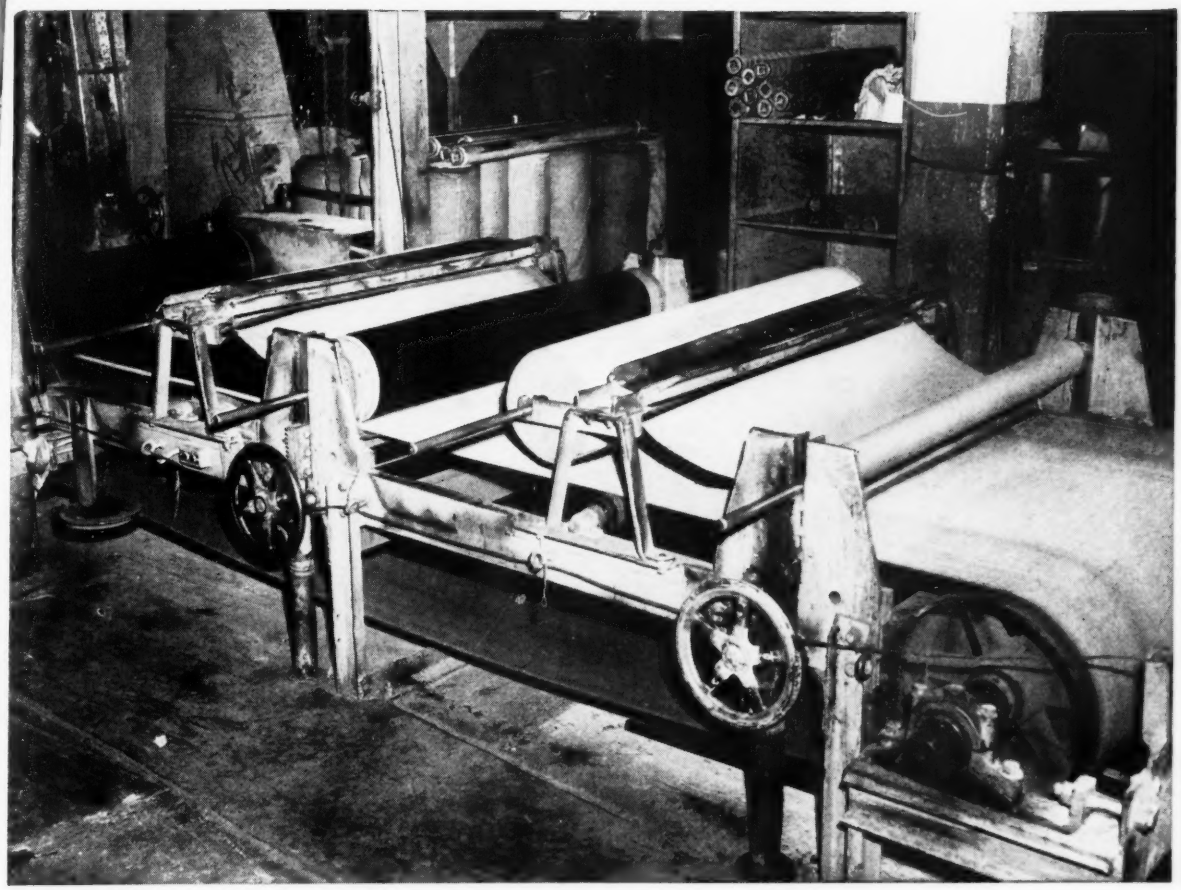
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